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## Noteworthy Snakes from British Honduras

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Previously we discussed some amphibians and reptiles taken in British Honduras (Neill and Allen, 1959a). Since then we have investigated Toledo District, a semi-isolated portion of that country lying mostly south of the Maya Mountains; and a description of the District's herpetofauna is in progress. During this last trip we also obtained specimens from Cayo and Belize Districts, north of the mountains. As certain of these do not come within the scope of other papers now in planning, we report separately on them. The present article is concerned with British Honduras snakes of the genera *Coniophanes, Conophis, Dipsas, Spilotes, Stenorrhina, Bothrops,* and *Crotalus.*

We are indebted to O. N. D. Phillips, of the British Honduras Forestry Department, for collecting permits and other favors; to Anthony Wolffsohn, of the same Department, for specimens and notes; and to Thomas C. Allen, Robert R. Allen, Anne P. Allen, Charles P. Day, Jr., and Harry T. Eaton for assistance in the field.

*Coniophanes schmidti* Bailey. This species has not previously been reported from British Honduras. A specimen was taken on a rocky hillside of Mountain Pine Ridge overlooking Augustine, Cayo District, on December 22, 1959, at an elevation of about 1700 feet. The snake (No. BH-945 in our separately catalogued British Honduras collection) is a female, 301 mm. in s-v length, 117 mm. in tail length. Its noteworthy features are: Scale rows 25; a small subpreocular present on each side; ventrals 153 (counted in the fashion of Dowling, 1951); subcaudals 93 pairs; dorsolateral light stripe 1 whole and 2 half scale rows wide, terminating anteriorly in a nape spot and thus separated from the light head stripe; on the neck, the lateral dark stripe 2 whole and 2 half scale rows wide, sharply defined both above and below; posterior to the neck this stripe about 1½ scale rows wide, its lower border not

sharply defined. No ocellus on parietals.

Although the snake is closer to *Coniophanes schmidti* Bailey (1937:1-3, 1939:31-32), it approaches *C. piceivittis* Cope in the width and distinctness of the lateral dark stripe on the anterior portion of the body. Nowhere on the body is this stripe as vague as in Bailey's figure of *schmidti* (1939:pl. 2, fig. 1). Nor is there a gradual darkening from the ventrals upward as in *schmidti;* the lower sides are uniformly colored as in *piceivittis.* The transition from the light gray-brown side to the brownish-black lateral stripe is accomplished in 1½ scale rows. The tendency of the dorsolateral light line to form a yellow nape spot suggests *C. frangivirgatus* Peters (1950:279), although in the latter this spot is separated from both head and body stripes. The top of the head is brown as in *C. p. taylori* Hall (1951:210) and *C. schmidti* but not in typical *piceivittis.*

*Coniophanes piceivittis* and *C. schmidti* are closely similar, vicariating forms (Bailey, 1937:3), and their probable conspecificity has already been suggested (Peters, *op. cit.*: 280; Martin, 1955:177). With *schmiditi* ranging southward to central Petén, Guatemala, and *piceivittis* northward to northwestern Honduras, it is geographically reasonable to expect intergradation in a zone that includes the hills of west-central British Honduras; and the somewhat intermediate nature of the Augustine snake might be deemed sufficient basis for the reduction of *schmidti* to a subspecies of *piceivittis.* However, the low ventral count of this specimen is puzzling. It may represent a local development, for the pine parkland of Mountain Pine Ridge is ecologically isolated by a ring of rainforest, jungle, and cohune ridge. These plant associations, and the peculiarities of the Ridge, have been discussed elsewhere (Neill and Allen, *op. cit.*: 13-15).

The Augustine snake is figured (Fig. 1).

*Conophis lineatus dunni* Smith. The many-lined snake was reported by Smith (1941: 123, 1942: 395) as far north as Managua, Nicaragua. Ross Allen and Wilfred Piper collected a number of these snakes much farther north, in Honduras. One of their specimens, in the Natural History Museum of Stanford University, was described by Savage (1949: 483), who gave its provenience as "Cofridia." The actual locality is Cofradía, Cortes Department, Honduras. It lies about 5 mi. S and 9 mi. W of San Pedro Sula, at a little less than 1000 feet elevation, on high ground overlooking a tributary of the Río Chamelecón. The general area, while perhaps originally forested, has been altered by cutting and burning.

Recently we reported the many-lined snake still farther north, at Augustine, Cayo District, British Honduras (Neill and Allen, *op. cit.*: 56). The specimen (ERA-WTN No. BH-300) is a large female, 917 mm. in total length, with the following characters:

Ventrals 166, subcaudals 65 pairs, scale rows 19-19-17. Black stripes sharply defined. A black stripe on scale row 1, fading out anteriorly as it nears the dark throat, and posteriorly terminating at the vent. A black stripe on row 3 and another on 4, the two separated around midbody but fused into a single line on the neck and also on the

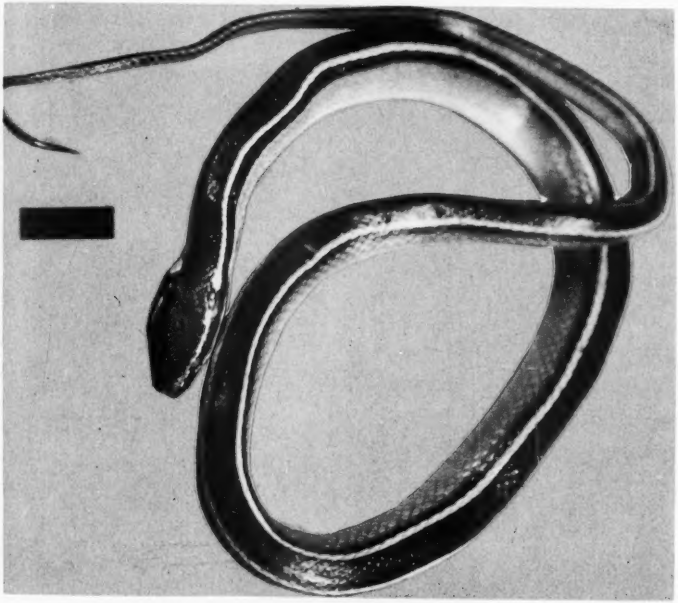

Fig. 1. ERA-WTN No. BH-945, *Coniophanes schmidti*. Dark bar indicates 1 cm.

posterior third of the body. The fused lines, two scale rows wide, extending anteriorly through eye to tip of snout; posteriorly extending to hinder fourth of tail. Yet another black line on row 7 (rows 6 and 7 posteriorly), on the neck approaching its fellow of the opposite side to terminate on a prefrontal, and posteriorly reaching about halfway down the tail. No secondary striping on row 8. Each ventral plate with a dark spot at its outer border. Most scales of row 2 with a black spot at the base, a pigmented center, and unpigmented edges and tips.

A second specimen (ERA-WTN No. BH-298) was taken on Brunton Trail in Mountain Pine Ridge, about 10 mi. E of Augustine, Cayo District, at an elevation of roughly 3000 feet, on Oct. 1, 1959. It is a smaller female, 578 mm. in total length (tip of tail missing). The ventrals number 162, subcaudal pairs 51+, scale rows 19-19-17.

The pattern is as in No. BH-300 except that a black stripe, extending backward from the snout through the eye to the end of the tail, does not split to involve rows 3 and 4, but merely forms a broad, heavy line on row 3; and the uppermost black stripe is on row 8 (row 7 posteriorly).

The Brunton Trail snake is figured (Fig. 2, upper left). It is considerably darkened by preservative. A third example from the Augustine area, not at hand, was photographed by Mr. Wolffsohn (Fig.4, upper). The illustration gives a better idea of the general appearance of Mountain Pine Ridge specimens.

These snakes show no approach to *Conophis lineatus concolor* Cope, which ranges from Yucatán and Campeche, Mexico, to Honduras (Smith and Taylor, 1945: 43). The approach is more toward *C. l. lineatus* (Duméril, Bibron, and Duméril) in that the second scale row bears some pigment. This was also the case in the Cofradía specimen. The circumstance bolsters the contention of Schmidt and Andrews (1936:178) that *concolor* is not a subspecies of *lineatus*.

Dunn (1937:214) described *Conophis nevermanni* from Costa Rica, and also indicated that the supralabials were immaculate in *C. lineatus*. In this he was followed by Savage (*op. cit.*: 484) and Taylor (1951:145). However, in *C. l. dunni* the supralabials are broadly dark-edged along the gape. This is illustrated by a photograph of *dunni*, misidentified as "*Liophis decoratus*," in Ditmars (1937: pl. 20).

Taylor (1955: 563-565, fig. 16) described and figured a Costa Rican snake as "*Conophis lineatus nevermanni*," with the comment that it was definitely not *C. l. dunni*. However, the description and photograph suggest *dunni;* both pattern and scalation are quite as in the Honduras and British Honduras examples, and there is no approach to the supposed characters of *nevermanni* (black with two light lines, ventrals 182 in the single known female).

Dunn (*loc. cit.*) stated that the range of *Conophis lineatus* in Nicaragua and Costa Rica (subspecies *dunni*) was "almost exactly that of *Crotalus* and *Salvadora*." The reference to *Salvadora* is obscure, the genus not ranging south of Guatemala; possibly Dunn had in mind *Leptodrymus pulcherrimus*, which during the 1930's was sometimes considered a *Salvadora*. At any rate the *Crotalus* could only have been *C. durissus*. In British Honduras this *Conophis* is associated with *Crotalus d. tzabcan* Klauber, both species being particularly characteristic of Mountain Pine Ridge. Also at Cofradía, Honduras, where *Conophis* was collected, *Crotalus* was common (March, 1928:55).

*Dipsas brevifacies* (Cope). On November 1, 1959, we collected a small dipsadine snake at a point about 13 mi. W and 1.5 mi. S of Belize, Belize District, British Honduras. (Directions are stated in terms of the cardinal compass points only, as recommended

by Riemer (1954:139). Distance is airline, measured from the nearest city limit of Belize, employing War Office Map GSGS 4767, Sheet 2, Edition 1.) The specimen (ERA-WTN No. BH-303) was ringed with deep, glossy black and clear white, closely resembling *Dipsas bicolor* (Günther) as figured by Taylor (1955: figs. 18-19, as *Neopareas bicolor*). However, the gular scalation was not that of *bicolor* but of *brevifacies*. A description follows:

First infralabials in contact behind mental, second infralabials in contact behind the first pair. Second infralabials followed by

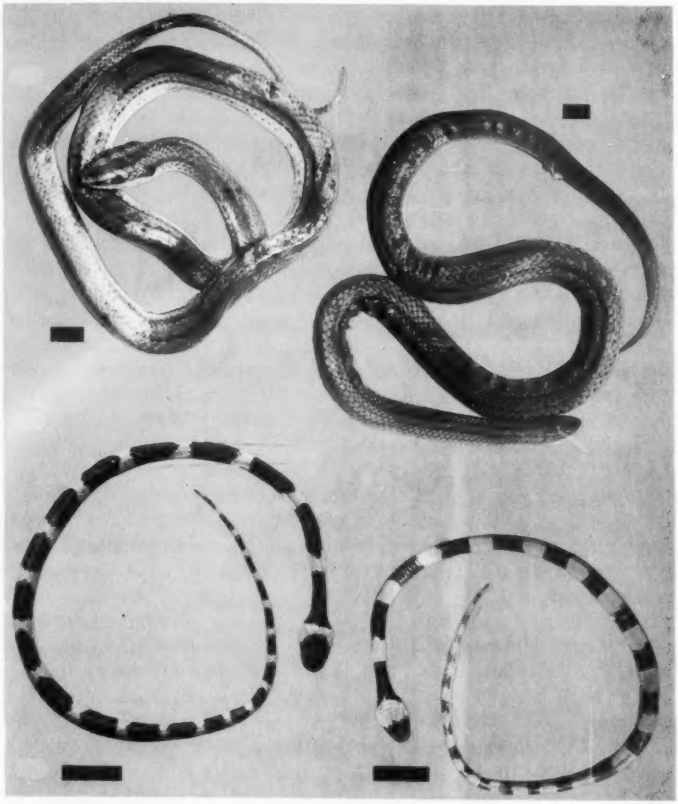

Fig. 2. Upper left: ERA-WTN No. BH-298, *Conophis lineatus dunni;* somewhat darkened by preservative. Upper right: ERA-WTN No. BH-681, *Stenorrhina f. freminvillei.* Lower left: ERA-WTN No. BH-303, juvenile *Dipsas brevifacies.* Lower right: same specimen, ventral view. Scale varies; dark bar indicates 1 cm.

a single pair of chin shields, each about as wide as long. This pair followed by a transverse gular shield, incompletely divided on the midline. (In the type specimen of *brevifacies* this scute must have been completely divided to form a second pair of chin shields, each broader than long; see Cope, 1866: 127.) Behind the incipiently divided scute, a longitudinal row of 6 transverse shields resembling ventral plates.

Head width contained 1.4 times in head length, neck width 2.5 times in head width. Body somewhat compressed, slender, muscular; tail prehensile. Head length 10.0, body length 150.0, tail length 56.0 mm., measured in relaxed, freshly killed condition. An umbilical scar present, longitudinally splitting the 34th and 35th ventral plates (counted forward from the vent.)

Rostral wider than high; internasals small, wider than long; prefrontals wider than long, each laterally in contact with a nasal, a loreal, and a preocular; nasal single. On the left side 2 loreals, one above the other, each separated from the eye by a minute preocular; on the right side 1 small loreal plus 2 larger scales which, although in contact with the orbit, evidently correspond to loreals or else to fused loreals and preoculars. Supralabials 11, the 5th and 6th entering the orbit. Anterior temporals 3 on the right, 4 on the left. Mental small, triangular. On the left 10 infralabials; on the right 12 plus 2 fragments.

Scales smooth, without pits. Scale rows 15-15-15, the median dorsal row not noticeably enlarged except for 3 scales above the anal region. Ventrals 173; anal undivided; subcaudal pairs 87. Sex ♂.

On casual inspection in life, the snake appeared to be black and white, with 1 white ring across the head, 14 on the body, and 11 on the tail (Fig. 2, lower left and lower right). On close examination, however, each white ring was seen to bear a small, middorsal, faint saddle of pinkish. In the terminology of Maerz and Paul (1950) the rings were 1 A 7, the saddles 1 B 8. The saddles vanished completely after about 3 hours in isopropyl alcohol. In life the eye was wholly black like the cap; the tongue was gray at the base, with whitish tips.

The type specimen of *Dipsas brevifacies* was marked with yellow annuli and a yellow head band (Cope, *loc. cit.*). Of course there is apt to have been some fading; the brighter colors of the dipsadine snakes may be especially fleeting in preservative (*cf.* Taylor, 1954: 769, on *D. anthracops*). An adult of *brevifacies* in life was ringed with pinkish-orange (9 A 8, bittersweet pink) and the head band was bright orange-red (1 C 12, flame scarlet), according to Schmidt and Andrews (*op. cit.*; 175, as *Sibynomorphus brevifacies*). We infer that there is ontogenetic increase of orange pigment in this species. Such increase is, of course, a widespread phenomenon among snakes.

The condition in *Dipsas brevifacies* also obtains, we suspect, in

the obviously allied *D. bicolor*. The type specimen of *bicolor* was black and white in preservative (Günther, 1885-1902:178), but could have had pink or orange markings in life. The collector of a Costa Rican *bicolor* thought that the light rings might have been pink or red in life, although they were white after some time in preservative (Taylor, 1955:571). A Nicaraguan example, which was seen in life, had red saddles on the white rings (Brattstrom and Howell, 1954:120); it was considered a new species and named *Neopareas tricolor*.

The British Honduras snake was found under a shower-of-gold orchid (*Oncidium* species), growing about a foot off the ground on the course bark of an oak (*Quercus oleoides*, var. *australis*), in an "oak island" of the palm and pine savanna. Elsewhere we have described this savanna (Neill and Allen, *op. cit.*: 12-13, figs. 4, 21). It extends in a north-south belt (with minor interruptions) from about Honey Camp in Orange Walk District southward to New Haven in Toledo District.

At the *Dipsas* locality were also found two racerunner lizards, of the species which elsewhere we added to the British Honduras list under the name of *Cnemidophorus gularis* (Neill and Allen, 1959c:236-237); and one silky anole, *Anolis s. sericeus*. About 150 yards away were found a Central American ground skink, *Lygosoma a. assatum*, and a Mexican tree snake, *Leptophis mexicanus* subspecies. The locality is in the same savanna as, and only 6 miles from, "Highland," where we took the poisonous treefrog, *Phrynohyas spilomma;* the airplant treefrog, *Hyla staufferi;* and the Central American ribbon snake, *Thamnophis sauritus chalceus* (Neill and Allen, 1959a:24, 26, 48). Likewise in the same savanna, at a spot about 15 miles from the *Dipsas* locality, we found the Belize garter snake, *Thamnophis praeocularis* (Neill and Allen, 1959b: 223). These batrachian and reptilian associates of *D. brevifacies*, in British Honduras at least, largely avoid rainforest (*Phrynohyas*, *Cnemidophorus*, both *Thamnophis*), or, if inhabiting forest as well as savanna, in wooded areas are generally to be found in the more open microhabitats—the edges of trails, clearings, bodies of water, patches of low brush, and the like (*Hyla*, *Anolis*, *Lygosoma*, *Leptophis*).

The previous inclusion of *Dipsas brevifacies* in the British Honduras herpetofaunal list has been based solely on a head without precise collecting data, found by Schmidt (*op. cit.*: 503, as *Sibynomorphus brevifacies*) in the natural history cabinet of a missionary.

Certain anatomical peculiarities of the dipsadine snakes are supposed to reflect a dietary specialization, malacophagy (Dunn, 1951; Mertens, 1952). The oak island, where our specimen was found, was littered with shells and living individuals of a snail. On Nov. 8, 1959, after a week in captivity, the snake voided blackish, tarry excrement, perhaps an indication of malacophagous diet.

At death the snake's mandibles were protruded and twisted outward, the clustered anterior teeth and whitish gums forming a tusk-like projection on each side of the jaw. Dunn (1951:356) mentioned this phenomenon in some members of the genus, but did not name the species in which he had observed it.

*Spilotes pullatus mexicanus* (Laurenti). A problem relates to ontogenetic color change in this snake. Smith (1943:471) noted that a juvenile from Mexico resembled the adults, whereas Taylor (1951:83) stated that a young example from Costa Rica differed from the adults in being marked with well defined crossbands.

The smallest specimen at hand (ERA-WTN No. BH-297) measures 451 mm. in snout-vent length, 144 mm. in tail length. It was taken near Guacamallo Crossing, Mountain Pine Ridge, Cayo District, British Honduras, on September 1, 1959, in hardwood forest at an elevation of about 1200 feet. In this individual there is a long umbilical scar, splitting 6 ventral plates and showing as a groove on 4 more. Probably the snake was but a few weeks old when collected and preserved. Its scale characters are as described by Amaral (1929:283) for *mexicanus*: loreal present; supralabials 8, 4th and 5th entering orbit; temporals 1+1; scale rows 18 at neck and midbody; ventrals 218; subcaudals 121 (a female). It is black, with 27 narrow, yellowish-white, fairly well defined crossbands on body, and 15 on tail. Anteriorly the bands form chevrons, with apices directed backward; but on the posterior third of the body they become approximately transverse. Apices of the first 4 bands are brighter yellow, and tend to be connected in a row of vertebral spots. Near mid-body there are 5 more light bands, incomplete dorsally and less distinct than the complete ones. These may be termed "secondary" bands, as contrasted with the 27 "primary" ones. The ventral plates are yellowish, the anterior ones mostly with black edges, the posterior ones with irregularly placed, squarish black spots. On the posterior half of the body, the ventral plates bear more black than yellow; anteriorly the reverse is true. There is a yellowish nuchal collar, broken at the midline, and emphasized anteriorly by a deep black border. The variegated, black and yellow head pattern need not be described in detail. The snake is illustrated (Fig. 3, upper left).

Our largest specimen (ERA-WTN No. BH-757) measures about 1840 mm. in snout-vent length, 430 mm. in tail length (tip missing). It was taken at Santa Elena, Corozal District, British Honduras, on July 18, 1959, in an area of dry, scrubby thicket at an elevation of just a few feet above sea level. Again there is agreement with the diagnosis of *mexicanus*: loreal present; supralabials 8, 4th and 5th entering the orbit; temporals 1+1; scale rows 18 at neck and midbody; ventrals 211; subcaudals 88+ (a male). The subcaudal count is incomplete, and one side of the head is mutilated so that details of scalation cannot be determined. The ground color is black. On the body there are about 30 or 31 chevron-shaped, primary crossbands,

straw-colored and proportionately wider than in the juvenile. The apices of the first 7 or 8 chevrons tend to form a broken, vertebral line. There are also about 16 or 17 secondary light crossbands, these being narrower, less distinct, and more irregular than the primary ones. Most of the secondary bands are complete. Precise band count is impossible owing to the irregularity of the pattern. The venter is colored much as in the hatchling, except that the black does not predominate over the yellow even posteriorly. The head pattern appears to be as in the young specimen, except for an increase in light areas. This snake is not figured, but a similarly patterned adult, taken in Mountain Pine Ridge, is illustrated from life (Fig. 4, center).

The ontogenetic trend seems to be toward an increase of the yellowish areas. The primary light crossbands widen with age; the secondary ones become more numerous and more frequently complete; the light areas of the head enlarge, and some of them coalesce; ventrally, the amount of yellow comes to exceed that of black. Carried a little further, the trend would result in a snake that appeared to be yellowish with some black chevrons. The light head areas, the yellow nuchal collar, and the yellow of the neck would coalesce; there would appear to be a black nuchal collar (originally the anterior border of a yellow one). The venter would be predominantly light. We have not seen such a fully developed light pattern in *mexicanus*. However, it characterizes many *Spilotes* from the vicinity of Barranquilla and the Magdalena River valley of Colombia (Fig. 3, right center). The circumstance bears out the contention of Taylor (1951:82) that the genus needs revision.

Amaral (*op. cit.*:297) characterized the genus as having a vertical pupil. This is in error; the pupil is round.

*Stenorrhina f. freminvillei* Duméril, Bibron, and Duméril. Schmidt (1941:506) reported "*Stenorhina degenhardtii*" from British Honduras. (The original generic name, *Stenorrhina* Duméril, was altered by Duméril, Bibron, and Duméril to *Stenorhina*, and the latter spelling has often been used.) At that time several snakes were lumped as *degenhardtii*. Schmidt's example was a female with 175 ventrals, 33 subcaudals, and a uniform coloration at a length of 490 mm. The high ventral count and the coloration imply that the snake was not *degenhardti*, which should be removed from the British Honduras list. In any event, this was another specimen without data, from the natural history cabinet of a missionary, and its precise identification would add little to our knowledge of the genus.

A *Stenorrhina* was taken on July 15, 1959, in Mountain Pine Ridge, on the outskirts of Augustine, Cayo District, British Honduras. The specimen (ERA-WTN No. BH-681) has a loreal, separating the prefrontal from the supralabials. The latter number 7, 3rd and 4th entering the orbit; infralabials also 7, the first pair in contact behind the mental. Two postoculars, 1 preocular; nasal fused

with internasal; temporals 1+2. Canthus rostralis pronounced. Scale rows 17 throughout; ventrals 175; subcaudals 38 pairs (a male). In preservative the dorsal ground color gray-brown (16 C 9), becoming slightly lighter on the sides. A well defined black vertebral line, one scale row wide (or a little less than that posteriorly), begin-

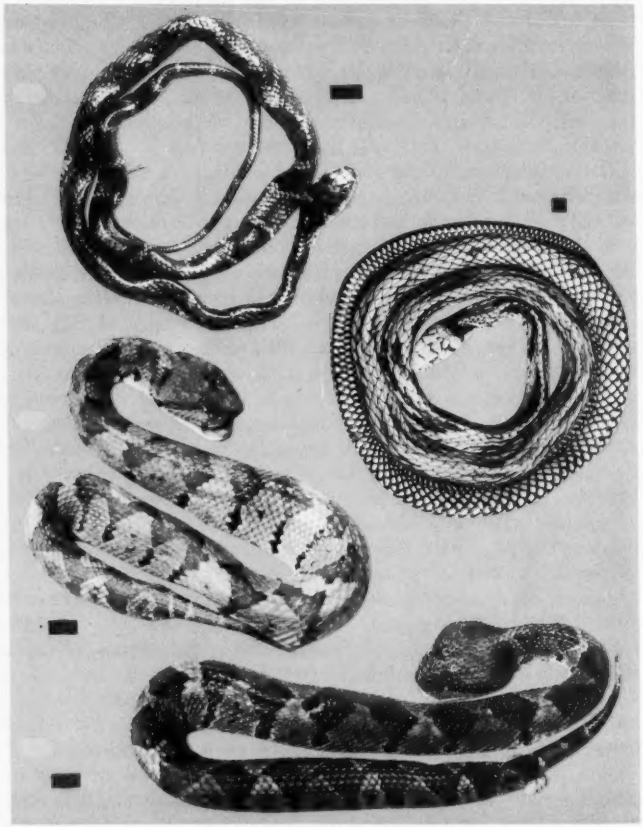

Fig. 3. Upper left: ERA-WTN No. BH-297, juvenile *Spilotes pullatus mexicanus*. Right center: large adult *S. pullatus* from Barranquilla, Colombia, showing maximum development of yellow in the pattern. Left center: ERA-WTN No. BH-805, adult female *Bothrops nummifer*; note diagonal postocular stripe and tendency toward a zigzag pattern. Lower right: ERA-WTN No. BH-683, adult male *B. nummifer;* note length of dorsal spots along the midline. Scale varies; dark bar indicates 1 cm.

ning at the parietals and extending to tip of tail. A dorsolateral black line beginning on neck and following scale row 6, extending onto base of tail; this stripe distinct on anterior third of body but posteriorly broken into spots, mostly on the scale apices. This stripe reintensifying on tail, following a suture between two scale rows (2 and 3 rows above the subcaudals). A black lateral line, evidenced on anterior third of body as a few scattered black flecks only, but posteriorly following the suture between the 3 and 4 dorsal scale rows; this line not reaching tail but terminating at level of vent. Upper labials yellowish-white. A vague, blackish temporal stripe on left side of head, the barest trace of such a stripe on right side. Ventral plates whitish, the last 100 or so each with a faint, cloudy spot in the middle. The midventral row of spots better defined under tail, there forming a gray line along the sutures between the subcaudal pairs. Throat a little darker than the ventral plates, with a large yellowish-white spot on the 4th infralabial and a smaller one on the 5th. A line of demarcation between lateral and ventral color. Many dorsal scales, below the lateral dark line and in the midregion of the body, with dark anterior margins; some ventral plates, in this same region, also darkened at the upper, anterior margin. Scalation, above and below, glossy and iridescent. Snout-vent length 477 mm., tail length 92 mm.

Judging from Taylor and Smith (1938:255), Smith (1943:472-473), Smith and Taylor (1945:132-133), and Stuart (1948:83), there are at least two distinct species of *Stenorrhina* in northern Central America, *S. degenhardti* and *S. freminvillei*. The Augustine specimen is clearly not the former, which usually has fewer ventrals, no loreal, a spotted or mottled dorsum, and a dark-spotted venter. The latter species has been divided into three subspecies, our example agreeing well with *S. f. freminvillei*. According to Smith and Taylor (*loc. cit.*) this race ranges only from Guerrero southward into Oaxaca and perhaps Chiapas, Mexico, being replaced in the Yucatán Peninsula by the unstriped *S. f. apiata* Cope; and by this definition the presence of a five-lined *Stenorrhina* in British Honduras would seem anomalous. Chrapliwy (1956:123) stated that the collection of *S. f. freminvillei* at Chacalapa, Oaxaca, extended the known range 41 miles southward. However, Smith and Taylor (*loc. cit.*) included *Microphis quinqueliniatus* Hallowell in the synonymy of *S. f. freminvillei;* and Hallowell's (1854:97) type specimen was from Honduras. Schmidt (1941:507) stated that Hallowell's example might have been from British Honduras, but today there is no reason to believe that such was the case. Barbour and Loveridge (1929:3, as *S. degenhardtii*) had, apparently, *S. f. freminvillei* from near San Pedro Sula, Honduras; Schmidt and Stuart (1941:245-246, as *S. degenhardtii*) had it from the Salamá Basin, Baja Verapaz, Guatemala; Stuart (1954:62-63, as *S. feminvilli*) had it from southeastern Guatemala. Mertens (1952:73-74)

secured several examples of typical *freminvillei* in El Salvador; he remarked that it was surprising to find his material referable to this form. Rand (1957:530-531) verified the presence of typical *freminvillei* in El Salvador. Apparently, then, the range of this snake is quite large, and includes British Honduras. The status of unicolor examples remains obscure.

The Augustine snake is figured (Fig. 2, upper right). The lineate pattern is far less conspicuous than in Mertens' (*op. cit.*: fig. 79) example. There may be in British Honduras some approach toward the unlined *Stenorrhina freminvillei apiata*.

Cope (1893:477), believing that the hemipenis of *Stenorrhina* had transverse flounces, placed the genus as the only New World member of the "Lycodontidae." Later, for the same reason, he considered it to be the only New World member of the "Homalopsinae" (Cope, 1900:1115). In this later work he figured the hemipenis of "*Stenorhina ventralis* Duméril and Bibron. Mexico" (pl. 27, fig. 8). The illustration bears no resemblance to the condition in our specimen. (Cope's 1900 paper appeared about three years after his death, and the labeling of the accompanying plates was highly erroneous.) Dunn (1928:21) characterized the hemipenis of *Stenorrhina* as of a "normal" type with "proximal hooks and distal calyces." In our example the organ is small, about five subcaudal plates in length. The hemipenial spines, small and irregularly arranged, are clustered toward the apex of the organ, so that a calyculate area is scarcely to be distinguished there; and the basal two-thirds of the hemipenis is bare of spines, except for two or three minute ones along the sulcus. Thus, except in a broad sense the organ is not like that of *Sonora*, to which genus *Stenorrhina* was thought allied (Stickel, 1943:111).

*Bothrops nummifer* (Rüppell). The nomenclature of the jumping vipers is so confused that a brief resumé is a necessary preliminary to discussion. Two subspecies have been recognized. These were diagnosed by Smith (1943:398-401), who, in the absence of intergradient examples, considered them to be distinct species. He assigned the name *nummifer* Rüppell to a more northerly population (Veracruz, Hidalgo, and Puebla, Mexico), and employed the name *mexicanus* Duméril, Bibron, and Duméril for a more southerly one. His specimens of this latter were from Santa Rosa, Chiapas, Mexico, and Piedras Negras, Petén, Guatamala. Smith and Taylor (1945:182) gave the range of *Bothrops mexicanus* as extending from Chiapas and Tabasco, Mexico, through Central America, with *B. nummifer* only in Veracruz, Hidalgo, and Puebla. Burger (1950) presented an abbreviated version of Smith's diagnosis, and followed Smith and Taylor's geographic arrangement, but considered the two forms to be subspecies intergrading in Oaxaca, Mexico. Burger (p. 63, footnote) did not see the holotype of *nummifer*, in the Senckenberg Museum, but obtained a description thereof from Robert

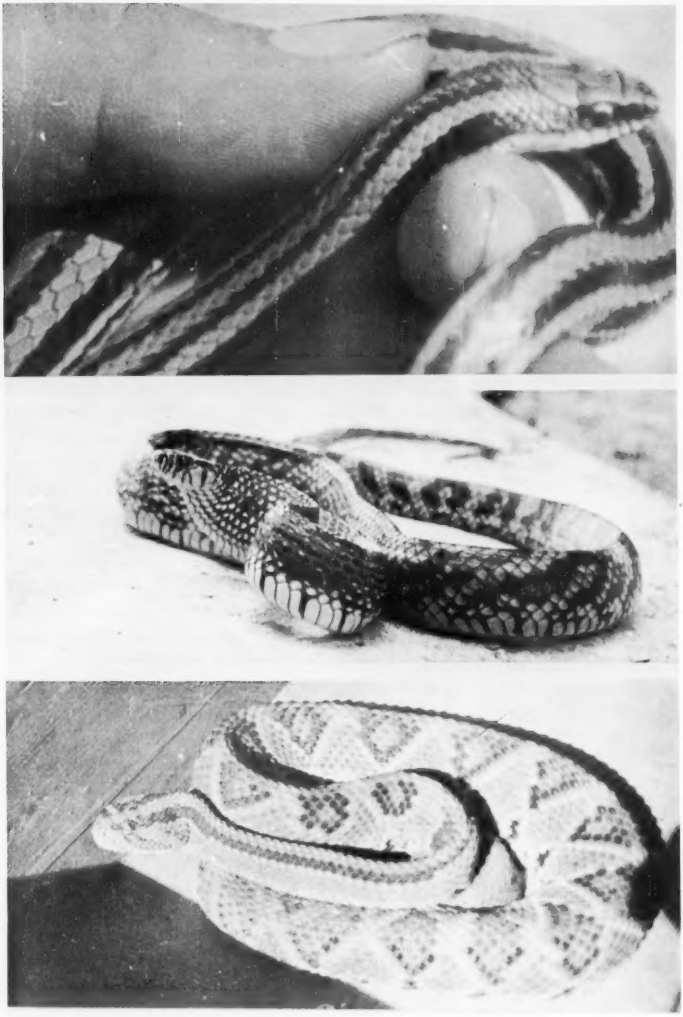

Fig. 4. Living snakes from Mountain Pine Ridge, Cayo District, British Honduras. Upper: *Conophis lineatus dunni* showing well defined lineate pattern. Center: *Spilotes pullatus mexicanus* showing typical adult pattern, and characteristic attitude when disturbed. Lower: *Crotalus durissus tzabcan*, adult showing pattern. Photographs courtesy Anthony Wolffsohn.

Mertens. Somewhat intermediate between the two forms, this specimen was considered by Burger to be closer to the more southerly one, which he therefore called *B. n. nummifer,* and of which *mexicanus* became a synonym. This interpretation left the more northerly population nameless, and Burger dubbed it *B. n. veraecrucis.* However, Mertens (1952a:78-79) considered the specimen to be closer to the northern (*i. e.,* the Veracrucian) form, which therefore became *B. n. nummifer;* and the name *mexicanus* was removed from the synonymy by Mertens and applied to the southern form of Burger. More importantly, Mertens found that his El Salvador examples agreed, not with the diagnosis of the "southern" form but with the Veracrucian one. Since the appearance of Mertens' paper, a few literature references to "*B. n. nummifer*" have been ambiguous, there being no indication as to whether the respective authors were following Burger's nomenclature or Merten's.

For convenience we refer to a "northern" form. This is the *Bothrops nummifer* of Smith (1943) and of Smith and Taylor (1945); the *B. n. veraecrucis* of Burger (1950); and the *B. n. nummifer* of Mertens (1952a). The "southern" form is the *B. mexicanus* of Smith, and of Smith and Taylor; the *B. n. nummifer* of Burger; and the *B. n. mexicanus* of Mertens.

Burger (*op. cit.*:64) cited five locality records for British Honduras. One of these, Double Falls, tentatively assigned by him to Toledo District, actually is in Stann Creek District. Another, "Cariblanca," was credited to Dunn (1939), but Dunn's actual reference was to Cariblanco, Costa Rica.

At hand are four more jumping vipers, all from Mountain Pine Ridge, Cayo District, British Honduras. ERA-WTN No. BH-683 is an adult male from Augustine. It displays the following "northern" characters: dorsal spots about 5 scale rows long on the dorsal midline; postocular dark stripe passing diagonally to the angle of the mouth, and extending well below the level of the rictus; 2 nasorostral scales on each side; a lower preocular present on each side. Its "southern" character is: 16 of the lateral spots fused to the dorsal ones. ERA-WTN No. BH-805 is an adult female taken on the north side of the Ridge at an elevation of about 2500 feet. Its "northern" characters are: dorsal spots forming a zigzag row posteriorly; postocular dark stripe passing diagonally to the angle of the mouth, and extending well below the level of the rictus; lower preocular present (on one side only). Its "southern" characters are: dorsal spots about 3 scale rows long on the dorsal midline (usually longer to one side or the other of the midline); 13 lateral spots fused to the dorsal ones; 3 nasorostral scales on each side. The adult snakes are figured (Fig. 3, left center and lower right).

ERA-WTN No. BH-807 is a juvenile male from the same locality as No. BH-805. Its "northern" features are: almost all the

dorsal spots fused into a zigzag row; dorsal spots about 5 scale rows long on the dorsal midline; postocular dark stripe passing diagonally to the angle of the mouth, and extending well below the level of the rictus. Its "southern" features are: 12 lateral spots fused to the dorsal ones; tail tip yellow; no lower preocular; 3 nasorostral scales on each side. ERA-WTN No. BH-808 is a juvenile female from Number One Lookout Hill at Augustine. Its "northern" characters are: dorsal spots about 6 scale rows long on the dorsal midline; a lower preocular on each side. "Southern" characters are: 11 lateral spots fused to the dorsal ones; tail tip yellow; postocular dark stripe less diagonal, not extending below the level of the rictus.

These specimens are intermediate between the "northern" and "southern" forms in the more important of the supposedly diagnostic characters. It is possible that the Mountain Pine Ridge population is aberrant; certainly the Ridge is an unusual area. However, its peculiarities are mostly those of the pine parkland biota, isolated by the rainforest that encircles the Ridge. The jumping viper is not of the pine parkland but of the bordering rainforest, and of the narrow belts of hardwoods along some of the streams. A continuous habitat, suitable for *Bothrops nummifer*, extends from Augustine southward through Cohune Ridge and Valentin to Esperanza; Burger's specimens and ours should be from a single, freely interbreeding population. Burger assigned British Honduras examples to the "southern" form. However, in discussing the somewhat intermediate nature of the *nummifer* holotype, he indicated that similarly or comparably intermediate specimens "are not infrequent in southern Mexico, Guatemala, and British Honduras" (*op. cit.*:59-60). What with the geographic anomaly of the "northern" form in El Salvador, and the intermediate nature of the British Honduras population, we omit a trinomial designation.

*Crotalus durissus* subspecies. Klauber (1952:71) described *C. d. tzabcan* from Yucatán and Campeche, Mexico. Recently we reported an isolated population of rattlesnakes in the Mountain Pine Ridge of British Honduras (Neill and Allen, 1959a:59-60; 1959c: 237-238). Our single example was referable to *tzabcan* rather than to typical *durissus*.

A second British Honduras rattler (ERA-WTN No. BH-806) is a young female with a complete rattle of 4 segments. It was collected on the northern side of Mountain Pine Ridge at an elevation of about 2800 feet. It exhibits the following characters: first infralabials not divided; ventrals 182 (counted in the fashion of Klauber, 1956, fig. 2:70); scale rows 27; supralabials 14; infralabials 15; neck stripe extending onto body for a distance of slightly more than 2½ head lengths; body blotches black with gray-brown centers, very distinct except posteriorly. Only this last character is *tzabcan*-like, and it probably reflects the youth of the snake.

A third example (ERA-WTN No. BH-954) was taken on the

main road in Mountain Pine Ridge, about 3 miles south of Augustine near Mahogany Creek, Cayo District, at an approximate elevation of 1300 feet, on February 6, 1960. It is a young adult male with a complete rattle of 10 segments. Its features are: first infralabials divided; ventrals 180; scale rows 27; supralabials 16; infralabials 16; neck stripe extending onto body for a distance of about 2½ head lengths; body blotches dark reddish-brown with tan centers, very distinct. The snake agrees well with the diagnosis of *tzabcan*.

The scant knowledge of British Honduras rattlers prompts the publication of Fig. 4, lower, although the specimen is not at hand. This is a large, living example collected in Mountain Pine Ridge. The pattern is distinct except posteriorly; the neck stripe is long.

The differences between *Crotalus d. durissus* and *C. d. tzabcan* are average ones. The juvenile, No. BH-806, may represent a fortuitous combination of typical *durissus* characters in a population that is essentially *tzabcan*.

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# On the Occurrence and Life History of *Contia tenuis*

*By* SHERBURNE F. COOK, JR.

Until recently, *Contia tenuis* (Baird and Girard), the sharp-tailed snake, has been found rather infrequently and regarded as one of the scarcer snakes on the Pacific Coast. It was described in 1852 from a specimen collected in the state of Washington (Proc. Acad. Nat'l. Sci., Phil. 6:176) and was not reported again from that state until 1939 (Slater, 1939). In recent years, however, scattered bits of information have accumulated to a point where a synthesis of this information unfolds a very unusual and interesting species biology. *C. tenuis* is not the rare species previously supposed but perhaps locally one of the more common species on the West Coast. Its period of activity and temperature tolerances may vary significantly from most other species within its range. Furthermore, the range, ecological distribution, and behavior of this snake appear to be closely correlated with a highly utilized food resource—an *introduced* genus of slug.

I wish to express my gratitude to the following persons for their cooperation and contributions to this paper: Dr. Gordon D. Alcorn, Dr. Seth B. Benson, Dr. I. McT. Cowan, Dr. Raymond B. Cowles, Dr. Cadet Hand, Dr. David L. Jameson, Dr. Earnest Karlstrom, Dr. Jean M. Linsdale, Dr. George S. Meyers, Richard W. Russell Dr. James R. Slater, the late Joseph R. Slevin, Dr. Richard C. Snyder, Dr. Robert C. Stebbins, Dr. Robert M. Storm, and Dr. Richard G. Zweifel. I am especially indebted to Dr. Robert C. Stebbins, whose extensive field notes contributed substantially to this publication, for his assistance and review of the manuscript.

*Contia tenuis* is a small, moderately stout colubrid, averaging about 12 inches in length. The tail ends with a sharply pointed scale, the function of which is not known, but which gives rise to the common name "sharp-tailed snake." The ventral scutes are light colored with sharply defined black anterior borders, making the characteristic pattern of black and white bands on the venter. The dorsum is reddish brown, quite vivid when young but fading with age.

The geographic range as presented by Stebbins (1954) is disjunct. Specimens have been taken in Washington only from the vicinity of the type locality ("Puget Sound Region") just southwest of Tacoma, and on North Pender Island in British Columbia. In Oregon, it occurs in the vicinity of Corvallis, Eugene, and near the California border. Additions to this range were furnished by Dr. Storm of Oregon State College, who has specimens from Roseburg and Myrtle Creek in Douglas County, Oregon. These would tend to bridge the gap between southern and west central localities in Oregon. In California it occurs in the south central coastal

region, northward to Oregon, across the northern part of the state and down the western side of the Sierra Nevada to a point at about the same latitude as the southernmost extension of its range on the coast. With a better understanding of this species the gaps in the range between California and Washington may possibly be filled (Fig. 1).

Whether the Washington localities represent isolated populations is unknown. However, Mr. William Woodin (in litt.) of Tucson, Arizona, found no consistent morphological differences between California, Oregon and Washington material. He says, "on the basis of the material examined, there appears to me to be no justification for a species breakdown." Admittedly, so few Washington and Oregon specimens are available that it is difficult to make any definitive statement regarding their possible subspecific status at this time.

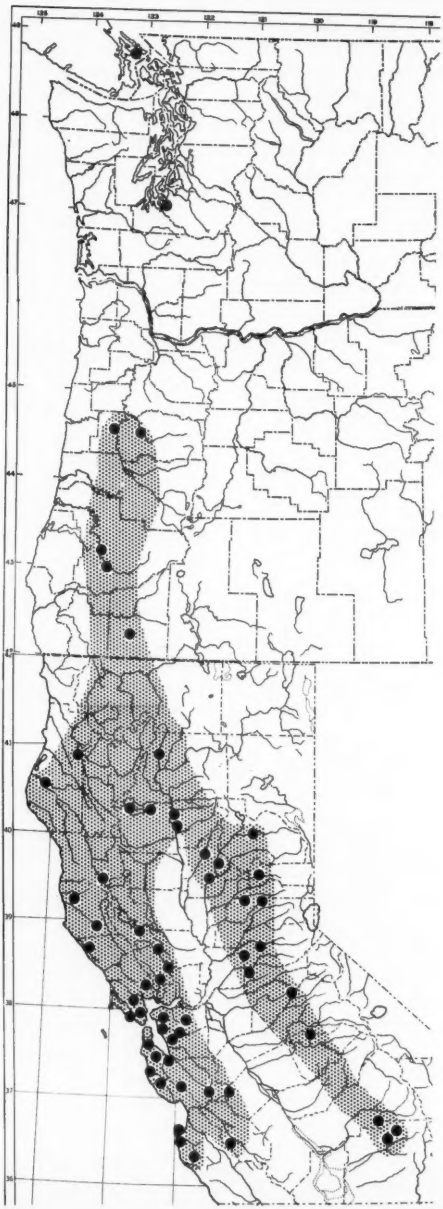
That the snake tends to be gregarious, or at least has a tendency to concentrate in small favorable areas, is suggested by several examples. The late Joseph Slevin of the California Academy of Sciences reported 8 collected under one log near Carlotta, Humbolt County, California, and 11 more under one pile of boards in Comptche, Mendocino County. Darling (1947) reported finding 23 of these snakes near Lebanon, Linn County, Oregon, and 24 individuals out of an estimated 40 collected were presented to me by Mr. Joseph Colaci, who helped collect them from one small area in the town of Castro Valley, Alameda County, California. More will be said regarding these and other similar examples presently.

The seasonal occurrence of *Contia* is summarized in figures 2 and 3 on the basis of 170 California and 66 Oregon specimens. The collection dates for those from North Pender Island are one each in June, July and August (Carl, 1950). Of the three collected in Washington, two were collected in August and one in July. It would appear that the populations to the north appear later than those in California and do not exhibit the activity increase in the fall (Figs. 2 and 3).

Compared to most snakes within the same range, the periods of activity for *Contia* differ considerably, especially in California. Most species show an increase in activity from late March or early April to late June or early July with maximum activity in May. A slight increase is usually noted about September due largely to the emergence of hatchlings. There is no evidence that the November rise in numbers of *Contia* (Fig. 2) is due to juvenile activity.

Grinnell, Dixon, and Linsdale (1930) listed *Contia* as being chiefly confined to the Lower Sonoran Life-Zone in the region they studied. Stebbins (1954) listed its occurrence in the Upper Sonoran and Transition. On the basis of the information gathered

Fig. 1. Distribution of the sharp-tailed snake, *Contia tenuis*.



here, it would appear that this snake, at least in California, is confined to the Upper Sonoran extending into the coniferous forests in the low elevation marginal or ecotonal areas. In Transitional regions the species has been found in valley floors, meadows, clearings, and usually associated with some Upper Sonoran vegetation, especially oaks. Dr. Storm told me that those collected near Corvallis, Oregon, were almost always in open meadows or pastures on the east edge of the fir forest of the Coast Range or among oaks in the lower foothills of these mountains. Anderson and Slater (1941) listed the distribution of *Contia* in Oregon as "from very restricted areas of the humid Transition and Upper Sonoran Life-Zones."

The forty-odd snakes collected by Mr. Colaci and friends were found in a back yard and adjoining vacant lots in the center of the town of Castro Valley—a rapidly growing suburb of Oakland. The immediate area, although probably at one time an open parkland, was occupied by supermarkets, motels, housing developments, and a super highway (U.S. 50), all within two blocks. The snakes were found under a collection of used tires in a back yard and under some broken cement slabs in a vacant lot nearby. Very few, if any, native trees adorned the landscape, and wild oats (*Avena fatua*) was dominant in the vacant lots. Undeveloped hills occurred within one mile. It might appear that *Contia* is concentrated locally because of such disturbance in the area. This is certainly a possibility, but is unlikely to be the complete answer.

Pleasant contrast in habitats were found in the experiences of Stebbins in Shasta County and Zweifel, Riemer, Karlstrom and me in Napa County. These habitats were very similar in many respects. The twelve specimens collected by Stebbins in Shasta County were found beneath digger-pine, blue oak and black oak logs in a small canyon with large tracts of chapparral (*Adenostoma fasciculatum*) nearby. The fifteen specimens collected in Napa County were also found beneath blue oak and digger-pine logs as well as under rocks in a live oak-madrone woodland.

Although Darling (1947) gives no detail regarding the 23 *Contia* collected near Corvallis, Oregon, Dr. Storm states that Darling found them under a few boards and describes the area as being "hilly with a few outcrops of loose, shaley rock." Apparently they are still common in this area even though a portion of it is now in a housing development.

That *Contia* respond positively to human activity in suburban areas is increasingly evident. Aside from the examples mentioned above, several more can be cited to corroborate this suggestion. In Orinda, California, a strictly residential suburb of Berkeley and Oakland, seven were found by Mr. Harry Noller, Jr. under two flagstones in his backyard. Dr. I. McT. Cowan of the University of British Columbia told me that the only three specimens known to

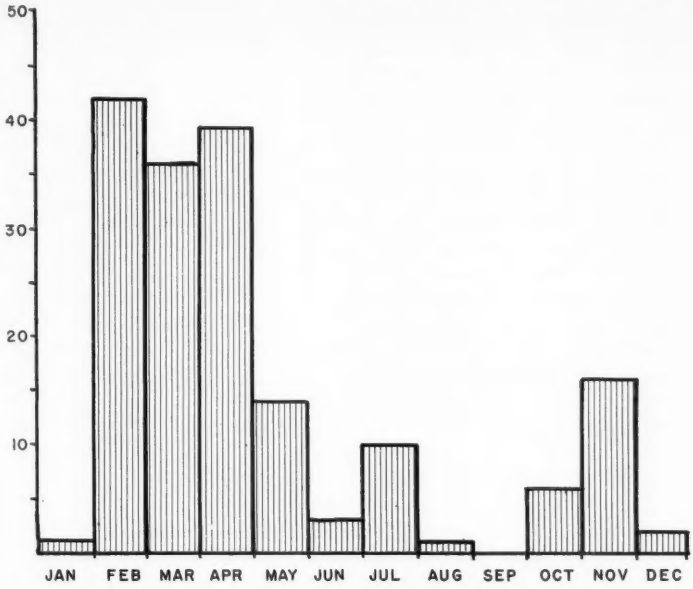



Fig. 2 Seasonal occurrence of *Contia tenuis* in California based on collection dates of 170 specimens.

him from British Columbia were all picked up in gardens and sent to him for identification. Ten of eleven specimens from Roseburg, Myrtle Creek, and Medford, Oregon were collected in gardens. One was found at an excavation for a new house, four under rocks and boards, and five more in another garden. Many of the specimens in the Museum of Vertebrate Zoology at the University of California have been obtained in a similar manner.

Dr. George S. Myers related, on the other hand, that according to the late Prof. J. O. Snyder, *Contia* was common in the vicinity of the Stanford Campus (Palo Alto, California) until the early 1920's. Subsequently, however, the arrival of a local specimen at the Natural History Museum has been infrequent. Dr. Myers suggested that this apparent local scarcity may be due to the great reduction in the water table through the continued use of artesian wells, changes in vegetation, and the heavy pressure of civilization. Nevertheless, of the 52 specimens I examined in the collection of the Natural History Museum at Stanford, 10 were collected on the University grounds and 17 from the general area. Although several of these were collected prior to the 1920's, many were taken in the last two decades.

Less typical records of occurrence can be noted. Several years ago I found one in the Gualala River, Sonoma County, California. It was within one foot of shore in rather quiet water. This river carries little water during the summer and in this area runs through a canyon dominated by douglas fir and redwood, with tanbark oak, live oak, deciduous oak, willow, alder, bay, and madrone growing nearby where conditions permit. Several more have been taken from the same area but under more typical circumstances. From the field notes of Dr. Zweifel comes the following: "Helen Jordan found a pair of large *Contia* under the bark of a standing dead oak trunk about 8 to 10 feet above the ground. Live oak and bay are present. The thick douglas fir and redwood forest does not reach down to the valley floor here." The snake reported by Slater (1939), the first reported in almost a century from near the type locality in Washington, was found in the basement of a house. Dr. James R. Slater of the College of Puget Sound stated that the only other two representatives known to him from Washington were found several years later on the same premises—one in the same basement and one under a rubbish pile in the yard.

The great majority of reports show this snake to be quite secretive and seldom found on the surface. Although a few exceptions have been mentioned here and others have been reported, most records of occurrence indicate a preference for remaining under cover. Road kills have been observed but are rare.

To my knowledge no studies have been conducted regarding temperature and humidity requirements of this species. Stebbins (1954) states that "in time of activity and places of occurrence, the sharp-tailed snake somewhat resembles our western plethodontid salamanders." From what has been mentioned previously regarding habitat and time of appearance, this conclusion appears to be generally justified except for its more complete mid-winter disappearance. Stebbins (*loc. cit.*) also states that "*Contia* seems to be adapted to relatively low temperatures and has found them active with food in their digestive tracts at cloacal temperatures of 52° to 61°F." The optimal temperature range of the snakes would appear to be lower than that of most snakes within their range. The largest numbers have been taken during the first few warm spells in late winter. In California this is usually in February or March—farther north in Oregon and Washington it is later. Many other examples could be cited, with few to the contrary, in support of this apparent affinity for cool, moist, surroundings.

Possibly the most important single factor limiting distribution is its food preference. Nearly all other aspects of its life history can be correlated with this one factor.

As far as is known, the diet of this snake is restricted exclusively to small slugs. Woodin (in litt.) reported that "of the 67 preserved

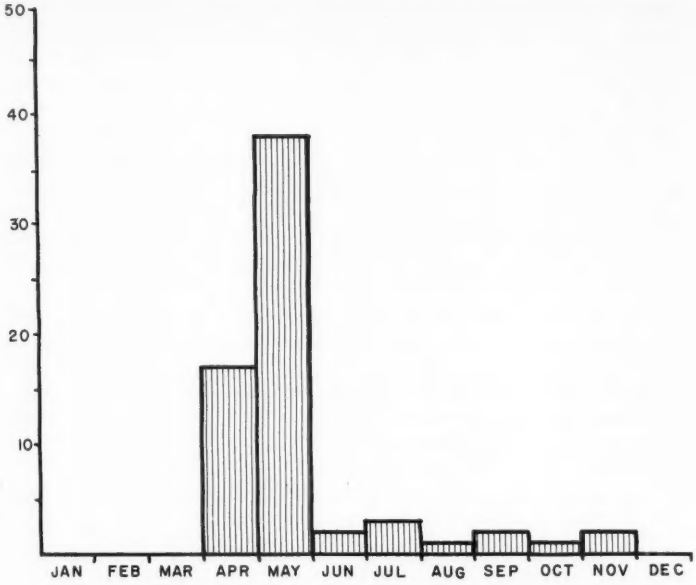



Fig. 3. Seasonal occurrence of *C. tenuis* in Oregon based on collection dates of 66 specimens.

specimens examined, slugs were found in nine, and no other identifiable remains were discovered." Mr. Woodin kept four individuals in a terrarium and offered them various types of food (earthworms, plethodontid salamanders, cranefly and other larvae, centipedes, millipedes, Jerusalem crickets, mealworms, and termites) to no avail. Small slugs, however, "were immediately grasped and readily swallowed by all four individuals."

Zweifel (1954) kept several of these snakes in captivity and also noted how readily they engulfed small slugs. For a snake so small it was cause for wonder how they could so rapidly swallow large slugs. In his field notes of February 6, 1947, Dr. R. C. Stebbins mentioned that one of several *Contia* collected on this day disgorged a slug.

Whether one species of slug is preferred over another is not known. By far the most wide spread and commonest small dark slugs within the range of *Contia* are species of the genus *Arion* (*A. ater, A. hortensis, A. intermedius,* etc.) introduced from Europe (Ingram and Lotz 1950, Pilsbry 1948). These are the only small slugs I have found commonly associated with the snake.

Apparently very few native slugs live in gardens except the

large banana slug (*Ariolimax* sp.). It is possible that juveniles of these slugs could be eaten by *Contia* but they are not nearly so abundant as are *Arion*. Obviously the conditions in gardens resulting from watering and cultivation create a favorable environment for these introduced slugs and *Contia* has responded accordingly. Perhaps this might explain their abundance in suburban areas.

The several small native slugs within the range of the sharp-tailed snake, are far less common than the introduced species and have a more restricted habitat. Just which native species, if any, previously occupied the niche now occupied by *Arion*, is not known. It is possible that with this introduction the ecological distribution of *Contia* has been modified.

Possibly related to this slug-eating habit is an unusual tooth development in *Contia* observed by Stickel (1951) and Zweifel (1955). Upon examination of skeletonized material, it was found that the teeth were greatly enlarged as compared to related genera. Such an enlargement, as was pointed out by Zweifel (1955), would certainly be an advantage to a snake feeding mainly, if not entirely, on slugs.

Since the slug-eating habits of this species appear to be well established, it would seem reasonable to conclude that the place and time of occurrence of *Contia* is correlated with the place and time of occurrence of its chief food. This could certainly explain the appearance of the snake early in the year and its affinity for cool and damp situations. It would also explain the November appearance in California with the first warm rains after a hot dry summer.

Whether *Contia* continue to feed during the summer or to estivate is not definitely known. Personal experience suggests the latter. In August, 1957, I dug one up in my yard that was tightly coiled in an earthen cell, suggesting a much moister condition when the cell was molded. The last heavy rains occurred in early April, four months earlier. The same summer I found another that had been unearthed and badly injured by a road grader. It was noted at the time that this one had nothing in its digestive tract.

Virtually nothing is known regarding reproduction in *Contia*. Small juveniles have been found in the spring and fall. Small ovarian follicles have been reported for this species by Dr. Storm in snakes taken in Oregon in June, August, and November. Five gravid females in the collection at the University of California contained follicles 5 mm. in length in March, 10 mm. in April, 14 mm. in June, and 7 mm. in November. The other, collected about July 1, contained eggs up to 41 mm., nearly half as long as the young snakes. The reason for this unusual size is not known. Careful examination of the 2 eggs failed to reveal any aberrancies. Very small juveniles between 103 and 105 mm. have been collected in Oregon

in April and May. The smallest juveniles in the Museum of Vertebrate Zoology are between 110 and 120 mm. total length. These were collected in January, March, October, and November.

The only really significant information at hand regarding reproduction was gathered by Dr. Stebbins from a gravid female collected July 3 from Butte County, California, and kept in the laboratory alive. The following account comes from his field notes:

"Five eggs were found in the container at 8:00 A.M., July 25, 1955. They had been laid sometime prior to that time and after 5:00 P.M., July 22, 1955.

"The eggs at this time measured respectively: 21.5 mm. x 6.63 mm., 21.15 mm. x 7.15 mm., 21.1 mm. x 7.10 mm., 19.8 mm. x 7.2 mm., and 19.7 mm. x 6.40 mm. The color was cream to pale yellow. There were no tubercles, but there were small rough striations on the egg along the long axis. Each egg had a pinkish embryonic area where blood vessels could be seen through the shell. One fresh egg was opened on this first day and the embryo preserved. The developing heart, optic vesicles, and major arteries and veins could be seen. Heart beat was 62 beats/minute at 26.7°C. The remaining four eggs were placed on moist paper in a covered jar and kept at about 20 to 26°C.

"By August 16, two of the eggs had spoiled. The two remaining eggs were measured on August 23 and found to be 20.7 mm. x 8.1 mm. and 21.6 mm. x 7.8 mm. One of these was opened November 2, and the embryo was found to be dead but well developed—75.5 mm. total length and 62.3 mm. snout-vent. The egg tooth and a small amount of yolk were found to be present. The last egg spoiled on or before November 10 and was found to be in about the same condition as the one observed on November 2."

From the available information it is not possible to say when the eggs are laid or when they hatch. Our limited data suggest that the date probably varies from the south to the northern part of its range. The little evidence we do have, however, suggests that eggs are laid in the summer and hatch in the fall.

To my knowledge no one has ever reported having found eggs in the field. Where they are laid and what conditions are necessary for their development are not known.

In view of the disjunct distribution and previously supposed scarcity of this species, the following list of locality records are appended to facilitate further study.

**Appendix I** - List of locality records for *Contia tenuis*.

**MVZ**—Museum of Vertebrate Zoology, University of California, Berkeley; **NHM**—Natural History Museum, Stanford University, Palo Alto, California; **CAS**—California Academy of Sciences, San Francisco; **OSC**—Oregon State College, Corvallis; **CPS**—College of

Puget Sound, Tacoma, Washington; **UBC**—University of British Columbia, Vancouver.

**California:**

**Alameda County:** Berkeley (MVZ); Piedmont (MVZ); Oakland (MVZ); Castro Valley (MVZ, NHM). **Amador County:** 5 mi. E Carbondale (MVZ); 1 mi. N Carbondale (MVZ). **Butte County:** Oroville (MVZ); Berry Creek (MVZ); 1 mi. S Paradise (MVZ). **Calaveras County:** Calaveras Grove (NHM). **Contra Costa County:** 3 mi. SSE San Ramon (MVZ); Orinda (MVZ); Mt. Diablo (CAS). **El Dorado County:** Placerville (MVZ); 4 mi. S Placerville (MVZ); Fyffe (NHM). **Fresno County:** Lake Sequoia (MVZ). **Humboldt County:** Carlotta (CAS); Willow Creek (MVZ). **Lake County:** Lower Lake (CAS). **Marin County:** 5 mi. NNE Nicasio (MVZ); Bolinas Bay (MVZ); Mill Valley (CAS); Ross (CAS). **Mariposa County:** Dudley (NHM). **Mendocino County:** Eel River Bridge (NHM); Comptche (CAS); Yorkville (CAS). **Monterey County:** 9 mi. W Jamesburg (MVZ); S end Carmel Valley (MVZ); Pacific Grove (NHM); Carmel (CAS). **Napa County:** 3 mi. N. **Napa** (MVZ); 18.1 mi. NE Napa (MVZ); 9.3 mi. NNW Monticello (MVZ); 6.5 mi. NE Napa (MVZ). **Nevada County:** Nevada City (MVZ). **Placer County:** ½ mi. N Dutch Flat (MVZ). **Plumas County:** Keddie (MVZ). **San Benito County:** 1 mi. NE Pinnacles National Monument (MVZ). **San Mateo County:** Belmont (MVZ); Jasper Ridge (NHM); San Andreas Lake (NHM); Pescadero Creek (NHM); Hillsborough (NHM); La Honda (NHM); Burlingame Hills (NHM); Woodside (NHM); San Mateo (NHM). **Santa Clara County:** Sunnyvale (MVZ); Pacheco Pass (MVZ); 5 mi. NE Gilroy (MVZ); Wrights Station (NHM); Palo Alto (NHM); Near Phelps Lake (NHM); Searsville (NHM). **Santa Cruz County:** Big Basin (NHM); Zungate (NHM). **Shasta County:** 23 mi. N Jct. US 299 and US 99 on US 99 (MVZ). **Sierra County:** Downieville (MVZ). **Sonoma County:** 35 mi. (by road) W Healdsburg (7 mi. E Stewarts Point) (MVZ); Sylvania (MVZ); Agua Caliente (CAS); Glen Ellen (CAS). **Tehama County:** 9 mi. SE Red Bluff (MVZ); 2 mi. SE Beegum (MVZ); 5 mi. NE Red Bluff (MVZ); Rosewood (NHM). **Tulare County:** Generals Highway, 5300', Sequoia Nat'l. Park (MVZ); Castle Rock Trail, 4200', Sequoia Nat'l. Park (MVZ); Ash Mt., Sequoia Nat'l. Park (MVZ).

**Oregon:**

**Benton County:** Within 15 miles of Corvallis (OSC). **Douglas County:** Near Myrtle Creek (OSC); Near Roseburg (OSC). **Jackson County:** Medford (OSC). **Linn County:** Near Lebanon.

**Washington:**

**Pierce County:** N end Gravely Lake (CPS).

**British Columbia:**

**North Pender Island** (UBC).

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UNIVERSITY OF CALIFORNIA
MUSEUM OF VERTEBRATE ZOOLOGY, BERKELEY

DIFFERENCES IN SHADE OF SOME REPTILES FROM THE NORTH AND SOUTH COASTS OF ORIENTE, CUBA.—In April, 1956, the opportunity presented itself to collect herptiles from the United Fruit Sugar Company property in the forested, humid Preston and Banes areas near Nipe Bay on the north coast of Oriente. In December, 1957, another collection was made in and near the U. S. Navy Base at Guantánamo in the dry, hot, cactus and brush covered hills on the south coast. In Puerto Rico and Jamaica the north and south coast vary similarly. Possibly as a consequence the color of the reptiles on the south coast is lighter than on the north coast.

The largely drab colored *Ameiva auberi* Cocteau at Banes is known as "iguanita," but at Guantánamo as "rabo azul" (blue tail). The difference in tail color is striking. The brilliant "electric blue" tail of the southern specimens arrests the eye when the lizard is either stationary or moving. The dorsal light brown stripe which usually dissipates at about midbody in the north is replaced by a white stripe which widens at base of tail to continue as electric blue on top, sides and distail end. Two light stripes, extending from above eye and ear, border a jet black instead of a mottled black and brown stripe to groin where the light stripes end, but the black extends far down sides of tail. A single wider white stripe beginning on rear of thigh extends a short distance down tail, merging with the blue as does a short extension of the white of venter; legs and feet mottled light and dark gray in contrast to light and dark brown on the north coast.

Four *Tropidophis melanurus* (Schlegel), taken by A. Speilman. A normally pigmented, 430 mm. s-v fits in well in color and squamation with 8 from Banes, described earlier (1957, Herpetological, 13: 154). The natives near Guantánamo call the albinistic specimens "culebra amarilla," yellow snake, believing it a distinct species. An albinistic specimen 380 mm. s-v differs from the northern one, 225 mm. s-v, in having terracotta stripe from eye, slightly darker than in Banes specimens, covering rows 6 and 7, disappearing near tail; another similar stripe from neck covering centers of spinal row only. Differs from the smaller northern specimen in lacking white spots where black spots normally occur, possibly due to ontogenic change or less complete albinism. No differences noted in scale counts.

Two *Epicrates angulifer* Bibron, one each Banes and Guantánamo; both males, about 4 ft. 6 in. long, similar in squamation except that upper right 8th labial enters orbit in the southern specimen. The background of the northern is distinctly brown in contrast to gray of the south. Respectively scale rows 58,60 at neck; 63,64 at 100th v; 49,47 at 200th v; and 31,30 at last (284,285) ventral.—*Chapman Grant, R. 1, Box 80, Escondido, California.*

# Reproduction in Oklahoma *Sceloporus* and *Cnemidophorus*

*By* CHARLES C. CARPENTER

In the course of an intensive five year study of the comparative ecology and behavior of *Sceloporus undulatus* and *Cnemidophorus sexlineatus* in Oklahoma an abundance of information concerning their reproductive habits was assembled. These observations were made primarily at the University of Oklahoma Biological Station on Lake Texoma, Marshall County, Oklahoma, but some of the lizards were captured in other parts of the state.

Gravid female lizards were readily detected, especially within a week or two of laying, by feeling the eggs through the abdominal wall. Thus, it was possible to determine the percentage of gravid females at different times during the spring and summer.

The first gravid females of *Cnemidophorus* were captured in May 9 (9 per cent of adult females gravid) with the per cent of captures showing this condition increasing into late July (56 per cent) followed by a sudden drop in early August (14 per cent) after which no gravid females were recorded (Fig. 1).

The earliest record for a gravid female *Sceloporus* was April 16 (12 per cent of adult females gravid in April) with the proportion increasing to a peak of 43 per cent in July and dropping off rapidly in early August (9 per cent) after which no gravid females were recorded (Fig. 1).

The earliest date observed for egg laying by *Sceloporus* was April 28, and for *Cnemidophorus* June 16 (Fig. 2).

The peak of laying activity for *Sceloporus*, as gathered from captive females, appeared in late June and early July, and this same peak for *Cnemidophorus* was July and early August (Fig. 2).

The number of eggs laid in a clutch was variable within each species, but *Sceloporus* clutch sizes were larger than those of *Cnemidophorus* (Figs. 3 and 4). The average clutch size for *Sceloporus undulatus* (all four races) was 7.21, ranging from three to thirteen eggs. The average clutch sige for *Cnemidophorus sexlineatus* was 2.46, ranging from one to six eggs. There was a direct correlation between female size (snout-vent length) and the number of eggs per clutch, in both species the larger clutches having been laid by the larger females.

The incubation periods for eggs varied between the two species (Table 1). The average period for incubation for *Sceloporus* eggs was 43 days, and ranged from 33 to 50 days. The average period of incubation for *Cnemidophorus* eggs was 53 days with a range from 46 to 63 days.

The date for the first observed hatchling *Sceloporus* in the field was June 24, and for *Cnemidophorus* it was July 12 (Fig. 2).

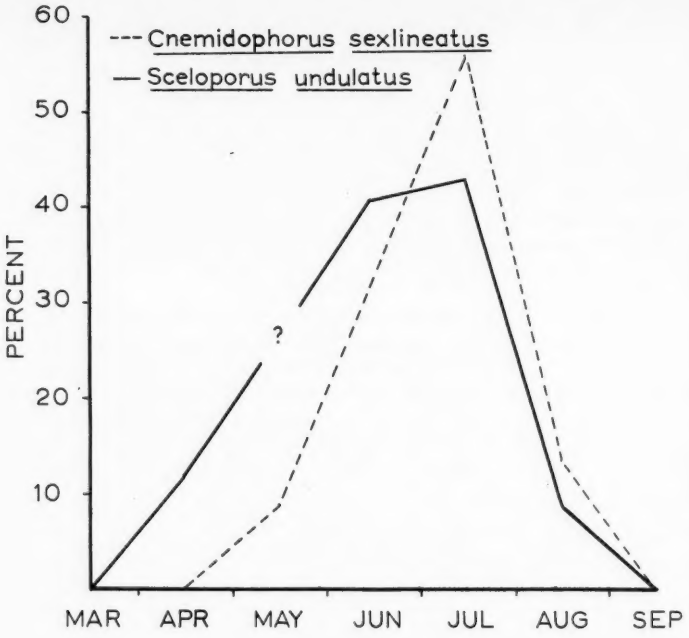



Fig. 1. The percent of captive adult female *Sceloporus undulatus* and *Cnemidophorus sexlineatus* from Oklahoma which were gravid, 1955-1959.

*Sceloporus* when compared to *Cnemidophorus,* lays more eggs per clutch, has a longer laying season and a shorter incubation period. Thus, *Sceloporus* has the greatest breeding potential.

Field observations indicated that female *Cnemidophorus* lay the eggs at the end of their burrows, three to six inches under the sand. One such nest was located approximately three inches down in a burrow when the observer attempted to dig up a retreating lizard. Two other nests were exposed, at Racerunner Bluffs, by erosion following a heavy rain. Both had two eggs and one pair was still in a small exposed cavity, probably the original nest cavity.

In the laying-in-jars (see below) in the laboratory at the Biological Station, both species constructed similar excavations in which to lay their eggs. These jars did not permit a choice of area, but they did indicate that both species will dig tunnels and lay their eggs underground. The excavations in these jars went to the bottom and the eggs were laid in a cavity large enough to contain the female and her eggs.

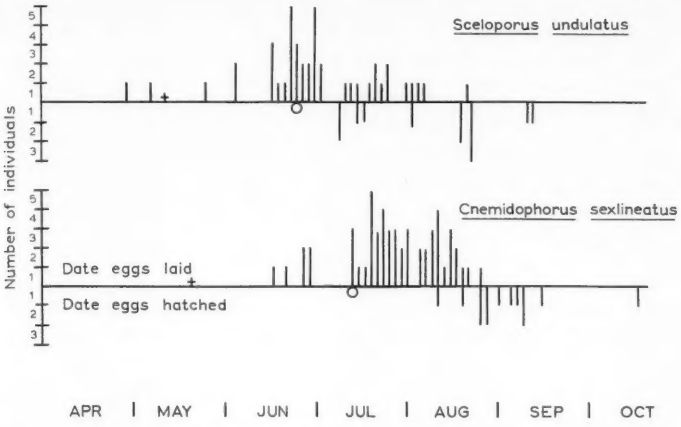



Fig. 2. The seasonal distribution of egg laying and hatching in captivity for *Sceloporus undulatus* and *Cnemidophorus sexlineatus* in Oklahoma. The circle represents the date for the first hatchling observed in the field, and the cross the calculated date of laying for this hatchling.

A female *Sceloporus undulatus erythrocheilus* was observed laying her eggs in a laying-in-jar on June 27, 1957. When she was first observed at 7:45 a.m., one egg had already been laid in a shallow cavity a little more than the height of her body and twice its width. The second egg appeared at 7:56 and took 20 seconds to emerge. At 8:03, the third egg began to emerge, 8:15 - fourth, 8:21 - fifth egg, 8:25 - sixth egg, 8:30 - seventh egg, 8:34 - eighth egg, 8:40 - ninth egg and at 8:48 the tenth egg.

The female, during laying, had her hind legs slightly extended and astraddle causing the pelvic region to form an arch. Just before an egg began to emerge, the female wiggled her body and arched the pelvic area a little higher. The tail was arched up and back during the laying. Intermittently, she jerked her body, made deep breathing movements with her abdomen, moved her body from side to side and moved forward slightly. Labor movements were apparent as muscular tightening in her abdominal region. When an egg had almost completely emerged, she would wag the pelvis as if to shake the egg free. This wagging of the pelvis had the effect of spreading out the accumulating eggs. During most of this laying activity, the female's eyes were closed.

After the last egg was laid, she became more alert as she raised

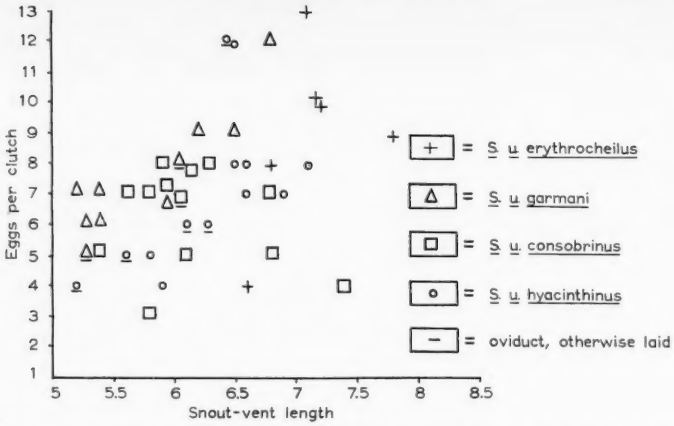

Eggs per clutch
Snout-vent length
+ = S. u. erythrocheilus
Δ = S. u. garmani
□ = S. u. consobrinus
o = S. u. hyacinthinus
– = oviduct, otherwise laid

**Fig. 3. The number of eggs laid per clutch as related to body length of the female for four races of *Sceloporus undulatus* in Oklahoma.**

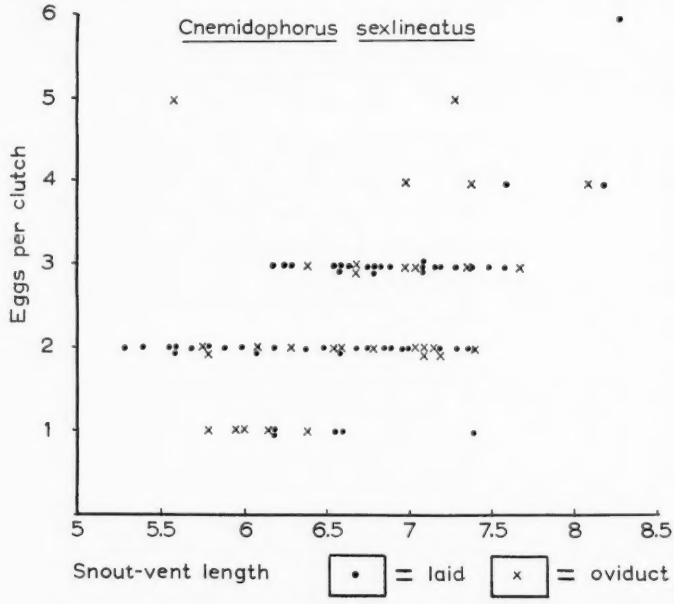



**Fig. 4. The number of eggs per clutch as related to body length of female for *Cnemidophorus sexlineatus* in Oklahoma.**

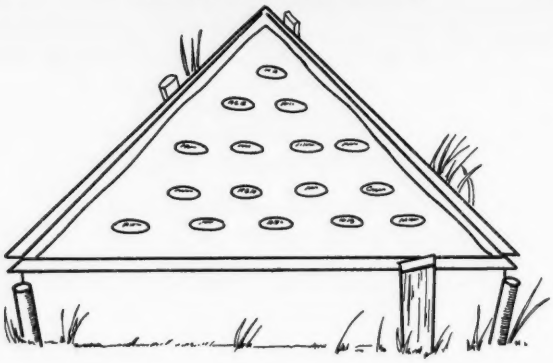
her head, lowered her tail and moved her body, then raised up and moved an inch, then turned and moved towards her eggs. At 9:05 a.m. she attempted to capture an insect on the outside of the jar. Between 9:15 and 9:30, she dug intermittently, using both front and hind legs. The confines of the laying-in-jar probably affected the results of this digging. However, her efforts did cover her eggs, whether intentional or not.

A female racerunner was observed laying her third and last egg in a laying-in-jar at 11:45 a.m. on June 28, 1959. She was in a cavity at the end of a tunnel at the bottom of the jar, with two eggs. Her position was much the same as that of the female *Sceloporus*, hind legs astraddle and extended forming a pelvic arch, with the tail arched up and back. Labor contractions were visible in her posterior abdomen. After two minutes the contractions appeared more vigorous, her pelvis rose higher, then the cloacal lips appeared to be swelling as the egg appeared. With another contraction, the egg passed out. She immediately rubbed her cloacal region back and forth on the bottom. She then pushed the egg posterior with her hind foot. She remained in this raised position for approximately ten minutes, and then relaxed, lying on top of the eggs. She made no attempt to cover them. These eggs later hatched on August 18.

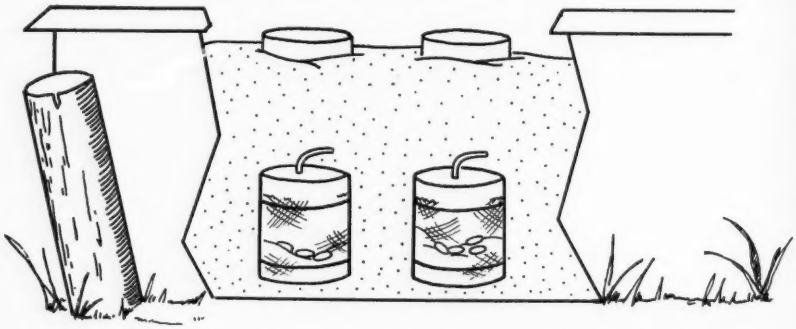
It is interesting to note that lizards held in captivity, in an active state, throughout the winter months attempt to court and mate. This was especially true for *Cnemidophorus*. Such activity resulted in the discovery of two eggs in a nest in the indoor enclosure at Norman in early February. These eggs appeared healthy at first, but later spoiled, but had undoubtedly been laid during January.

For a number of years at the Biological Station attempts had been made to hatch reptile eggs, but with little success. Most of these attempts were made in the laboratory; burying the eggs in sand contained in card-board cartons, burying them in wood debris, or holding them in moist aquarium chambers after being dipped in fungicide. None of these were successful, for most eggs developed fungal infections.

During the summer of 1958, the following method was developed and continued through the summer of 1959. A triangular sand box, eight feet on a side and ten inches high, was constructed and filled with sand. (Fig. 5(a)). The triangular shape was used so that all areas were accessible from outside the box. The eggs were placed in *incubator tubes*. (Fig. 5(b)). The "inctubes" were first made of hand-bent cones of iron screen, which rusted apart after a month. The material used was then changed to copper screen. Using large disc-shaped corks at either end, a cylinder of copper screen was fashioned and tacked to these corks, with one cork (having a wire handle) removable as an access door. The size of the "inctubes" varied in diameter from one and one half to three inches and from three to six inches in length. The smaller containers



a



b

Fig. 5. a. Sketch of incubator box for reptile eggs.
b. Sketch of a section through the side of the incubator box showing the incubator tubes in position, with a marker on the sand above.

were used for small clutches of small eggs, the larger tubes for the larger snake and turtle eggs.

The eggs were placed in the inctubes as soon as possible after laying, and after being weighed and measured. About one half inch of damp sand was placed on the bottom of the inctube and the eggs were placed on the sand but were not covered. This left the eggs in a small open chamber. The inctube was then buried in

the sand box so that there was three to four inches of sand above it. The sand in the box was kept slightly damp, but not wet. Sand usually leaked into the tubes, but this sand was very loose and was removed when they were checked.

Identifying information (usually just species and date of laying) was placed on a small rag paper label in each container and also on a marker placed immediately over the tube on the surface of the sand.

These inctubes were checked at varying periods of from every other day to once a week, and towards the suspected time of hatching, once or twice a day. It is now recommended that they be checked at least once every other day from the start. The frequent inspection is to assure that grass and weeds have not grown into the tubes and that ants have not reached the tubes, for this did happen and some clutches were destroyed. Since it was learned that

| *Sceloporus undulatus* | Date laid | Date hatched | Incubation Period (days) |
|---|---|---|---|
| *consobrinus* | 6-17-59 | 8- 2-59 | 46 |
| " | 7-11-58 | 8-22-58 | 42 |
| " | 7-13-58 | 8-22-58 | 40 |
| " | 7-24-59 | 9-12-59 | 50 |
| *garmani* | 6- 3-59 | 7- 6-59 | 33 |
| " | 6- 4-59 | 7-13-59 | 39 |
| " | 7- 3-59 | 3 on 8-18-59 | 46 and |
| | | 1 on 8-22-59 | 50 |
| *hyacinthinus* | 7- 1-59 | 8-18-59 | 48 |
| " | 7-30-58 | 9-10-58 | 42 |
| *Cnemidophorus sexlineatus* | | | |
| " | 6-20-59 | 8-10-59 | 51 |
| " | 6-28-59 | 8-18-59 | 51 |
| " | 7- 3-59 | 8-24-59 | 52 |
| " | 7- 3-59 | 8-24-59 | 52 |
| " | 7- 5-59 | 8-26-59 | 52 |
| " | 7- 8-59 | 8-31-59 | 54 |
| " | 7-11-59 | 8-26-59 | 46 |
| " | 7-12-58 | 9- 3-58 | 53 |
| " | 7-14-59 | 9- 9-59 | 57 |
| " | 7-16-59 | 9- 8-59 | 54 |
| " | 7-26-59 | 9-13-59 | 49 |
| " | 8-13-59 | 10-15-59 | 63 |

Table 1. Incubation periods for the eggs of two Oklahoma lizards.

these eggs increased in size considerably after laying, all clutches were removed temporarily and remeasured after 3 or 4 days to a week.

The box containing the tubes was in an open area completely exposed to the sun which simulated, it was believed, natural conditions.

This method was very successful; allowing for infertile eggs and failure to check properly, an estimated 85 per cent.

Since it was necessary to leave the Biological Station before many clutches had hatched, the tubes were placed in sand filled boxes and moved to the behavior laboratory in Norman. Here they were similarly buried in sand in the indoor experimental habitat, where many hatched out as late as mid-September. This removal to an indoor environment, away from the heating effect of the sun, appeared to slightly prolong the incubation period, indicating the influence of temperature upon the length of time required for development (Table 1).

This method could possibly be adapted for use in studying reptile embryology. The success was probably due to the fact that this method simulated very closely the natural nest for most reptiles.

To assure us that eggs would be found as soon as possible after they were laid, the following method was used.

As soon as a gravid female was detected, she was checked every day or so until believed to be near laying, at which time she was placed in a laying-in container. This container was usually a wide mouthed gallon jar with about 3 inches of damp sand on the bottom. The gravid female was kept in this jar until she had laid or it was apparent she was not going to lay.

In the laying-in-jars, the female laid her eggs in a chamber she had dug on the bottom under the sand. Since a number of females died in these jars before they laid, this method needs improvement. The females readily fed in these jars.

DEPARTMENT OF ZOOLOGY, UNIVERSITY OF OKLAHOMA, NORMAN, OKLAHOMA

RECORD SIZED *STORERIA*.—On March 15, 1960, I captured a 19¾ inch specimen of *Storeria dekayi wrightorum*.

This exceeds a record of 19 inches published in Copeia (issue unknown) and a 18⅝ inch record appearing in Conant's Field Guide (1958).

The specimen was taken in a suburb of Atlanta and is now in the collection at the Georgia State Capitol.—*Warren L. Bond, College Park, Georgia.*

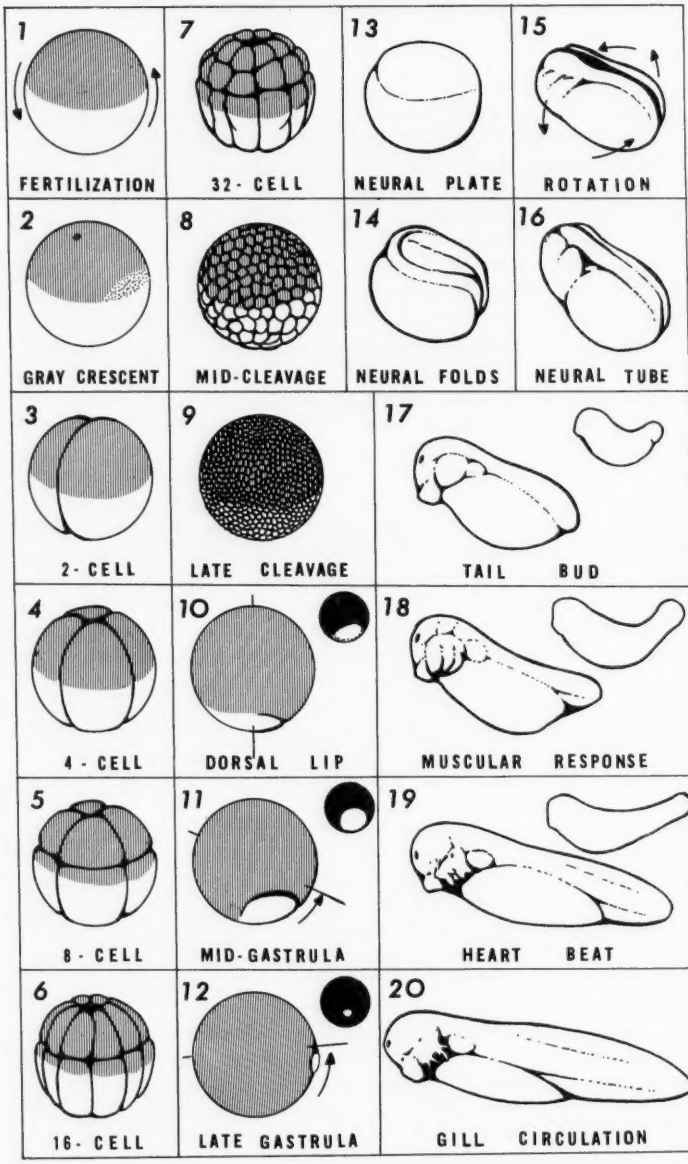
# A Simplified Table for Staging Anuran Embryos and Larvae with Notes on Identification

*By* KENNETH L. GOSNER

The description of anuran embryos and larvae is facilitated by the use of staging tables, and such tables are indispensible to many studies involving frog life-history materials. Earlier papers in this field by the present author and others adapted existing tables to this purpose. Since this literature now involves two systems for numbering the larval stages, a brief review of the problem is in order, and a simplified table adequate for staging "generalized" developmental series will be presented. The proposed table is original only to the extent that it is a simplification of those already in existence.

Twenty-five prefeeding stages of *Rana pipiens* were tabulated by Shumway (1940), (reprinted in Rugh 1951), and tables, less complete in some cases, are available for several other species (see reviews by Limbaugh and Volpe 1957, and Rugh 1952). The above tables show essentially equivalent stages designated by consecutive Arabic numerals and are adaptable to staging embryos of other species. For postfeeding stages the Taylor and Kollros (1946) table for *Rana pipiens* has proved useful, (also reprinted in Rugh 1951, 1952), and can be adapted for staging other tadpoles. This table shows twenty-five stages designated by Roman numerals. Unfortunately the numeration in the Taylor and Kollros table is not consecutive with that of the embryonic series. More recently Limbaugh and Volpe (*op. cit.*) published a complete table of embryonic and larval stages of *Bufo valliceps* using Arabic numerals throughout and designating forty-six stages. This system was followed in a subsequent paper by Volpe (1959) and also by Gosner and Black (1958), both treating larval toads. The latter authors also indicated that stages in the Limbaugh and Volpe table are essentially equivalent to those of previous authors except that larval stage 40 of Limbaugh and Volpe contains stages XV-XVII of Taylor and Kollros while stage 41 includes stages XVIII and XIX. This reduction in the number of larval stages represents a desirable simplification as, most certainly, is the use of a consecutively numbered sequence for both embryos and larvae. Adoption of this system for general use is, therefore, strongly recommended. To facilitate such adoption the following table is presented, based on that of Limbaugh and Volpe and excluding only details likely to prove specifically variable. Equivalent Taylor and Kollros Roman numeral stages are given for ease of comparison with earlier papers using this system. The proposed table should prove adequate for staging developmental series of most North American pelobatids, bufonids, hylids, and ranids, at least. Since identification of stages is most readily ac-

TABLE 1


1
FERTILIZATION
7
32- CELL
13
NEURAL PLATE
15
ROTATION
2
GRAY CRESCENT
8
MID-CLEAVAGE
14
NEURAL FOLDS
16
NEURAL TUBE
3
2- CELL
9
LATE CLEAVAGE
17
TAIL BUD
4
4 - CELL
10
DORSAL LIP
18
MUSCULAR RESPONSE
5
8 - CELL
11
MID-GASTRULA
19
HEART BEAT
6
16- CELL
12
LATE GASTRULA
20
GILL CIRCULATION

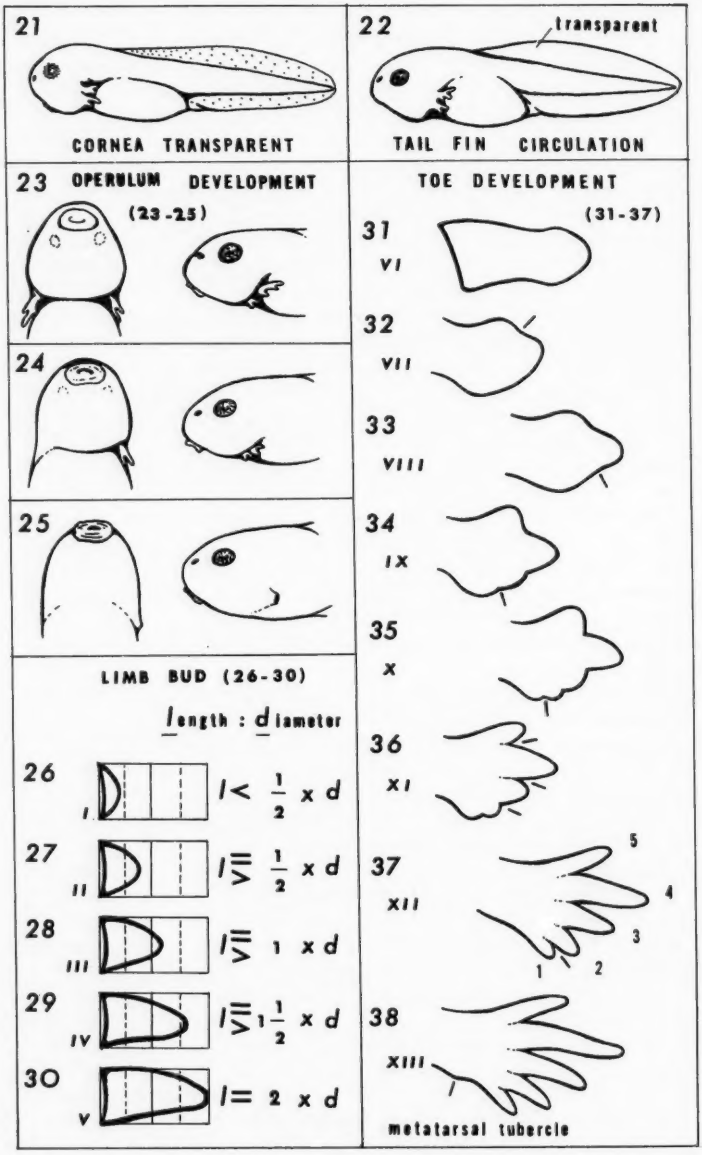
complished by reference to the illustrations, the textual comment will be kept to a minimum. For a full account of early development, see Rugh 1951.

Embryonic Stages—Stages 1 through 25 contain the embryonic or prefeeding series. The number and size of the jelly envelopes and the size and rate of development of the embryo are both individually and specifically variable; hence, such details are excluded from the general table. Egg color also varies systematically among North American anurans. The sequence of changes in the early embryo from fertilization through cleavage, blastula, and gastrula are, however, essentially similar in most species. Fertilization, stage 1, is indicated by rotation of the embryo until the animal pole is uppermost. In stage 2 the second polar body is expelled and a lightening (grey crescent) appears on part of the pigmented hemisphere opposite the point of sperm penetration; these details are not conspicuous without close examination. Seven cleavage stages follow, as illustrated; the early cleavages are regular and more or less symmetrical. After the fourth cleavage, stage 6, cell division is less regular. Stages 7, 8, and 9, are differentiated by the size of the blastomers; also, between stages 8 and 9 the light "hemisphere" is reduced in size through expansion of the darker area.

The involution of cells at a point on the boundary between dark and light hemispheres is taken to indicate the beginning of gastrulation, stage 10. In describing new material, measurements of "egg diameter" should be made prior to this stage, if possible, since the embryo will shortly assume an oval shape; also, the perivitelline capsule absorbs a considerable amount of water in subsequent stages and its diameter cannot be taken as an accurate indication of the initial size of the "vitellus". During the period of blastopore formation, stages 11 and 12, the balance of the live embryo shifts, and the blastopore, initially ventral, becomes the posterior pole of the anterior-posterior axis. The small protruding plug of yolk cells gradually disappears, and the neural plate, stage 13, develops as a tabular area on the dorsal surface. Stage 14, neural fold, is marked by elongation of the embryo and the elevation of two lateral ridges separated by the neural groove. The groove narrows and the folds approach each other as periods of active ciliary rotation of the embryo within its capsule begin, stage 15. At stage 16 the neural folds are closed forming a neural tube; the gill plates become conspicuous, and the embryo begins to develop a recognizable "head."

During the succeeding three stages hylid embryos may appear somewhat dissimilar to those of other families because of their strongly arched form. This difference appears with the development of the tail bud, stage 17. Stages 18, 19, and 20 are differentiated mainly on the basis of relative development of the external gills and tail. Division of the gill plate into ridges (visceral

TABLE 2


21
CORNEA TRANSPARENT
22
transparent
TAIL FIN CIRCULATION
23 OPERULUM DEVELOPMENT
(23-25)
24
25
LIMB BUD (26-30)
length : diameter
26
I
l < 1/2 x d
27
II
l = 1/2 x d
28
III
l = 1 x d
29
IV
l = 1 1/2 x d
30
V
l = 2 x d
TOE DEVELOPMENT
(31-37)
31
VI
32
VII
33
VIII
34
IX
35
X
36
XI
37
XII
1
2
3
4
5
38
XIII
metatarsal tubercle

arches) takes place in stage 18, and in stages 19 and 20 there is progressive development of external gill filaments. These vary to some extent both systematically and individually in size and extent of branching. Full development of the external gills comes between stages 21 and 23. In life, stage 18 is recognized by the initiation of spasmodic muscular responses (simple flexures) and stage 19 by the heart beat, a visible pulsation below and behind the gills, most apparent when the embryo is viewed in profile. In stage 20 gill circulation may be seen as a movement of corpuscles through the external gill filaments. Embryos of most species hatch between stages 17 and 20; the stage at which this normally occurs varies systematically and to some extent individually.

Development of the adhesive organs (oral suckers) may be observed through stages 17-21; their form varies both systematically and ontogenetically. In most larvae the organs are united initially as a crescent shaped ridge which becomes bifid at full development; in *Scaphiopus*, however, the sucker remains U or Y shaped. Following stage 21 these organs rapidly disappear, their scars seldom remaining past stage 26 except in *Scaphiopus*.

Stages 21-25 witness the transition to a feeding and free-swimming tadpole. This is a difficult period for species identification. In stage 21 the cornea become transparent and the eyes are clearly discernable; tail fins are still opaque. In stage 22 the fins become transparent and circulation with them begins. Stages 23, 24, and 25 mark the development of the operculum and consequent disappearance of external gills; these changes may be noted most readily by viewing the embryo in ventral aspect. From stage 25 on, a spiracle is present on the left side of most North American tadpoles except microhylids, where it is ventral and near the anus.

In stages 23-25 there is initial formation of pigmentary patterns, chromatophores of several types appearing at about stage 23-24. At least three types of color cells occur in tadpoles. Melanophores contain a dark, relatively insoluble pigment, presumably melanoid in chemical makeup. Lipophores (xanthophores) contain soluble transparent or translucent pigment, usually yellow, orange, or red; this pigmentation often gives the appearance of a "dispersed color," and recognition of individual chromatophores may be difficult or impossible under ordinary viewing conditions. Iridophores (leucophores or guanophores) contain opaque or milky pigment that is altered on preservation; color bodies of this sort presumably contain guanine and are responsible for irridescent and metallic effects. These colors, like those due to lipophores, are lost on preservation.

The formation of head-body patterns is a complex matter in tadpoles, depending initially on melanophores in the deeper tissues and on visceral elements as well. The intensity of overall color varies, chiefly with the number and state of expansion of the mel-

anophores, and is, to some extent, environmentally controlled. Ontogenetic changes in pattern are due partly to an increase in surface pigmentation masking that in deeper tissues. Recent papers show increasing reliance on tail pigmentation patterns for species identification in toads and hylids particularly. These patterns begin to develop at about stage 24. Pigmentation of the tail fins appears to be less reliable for identification than that of the tail musculature. Considerable ontogenetic change occurs in both fin and musculature patterns in some species.

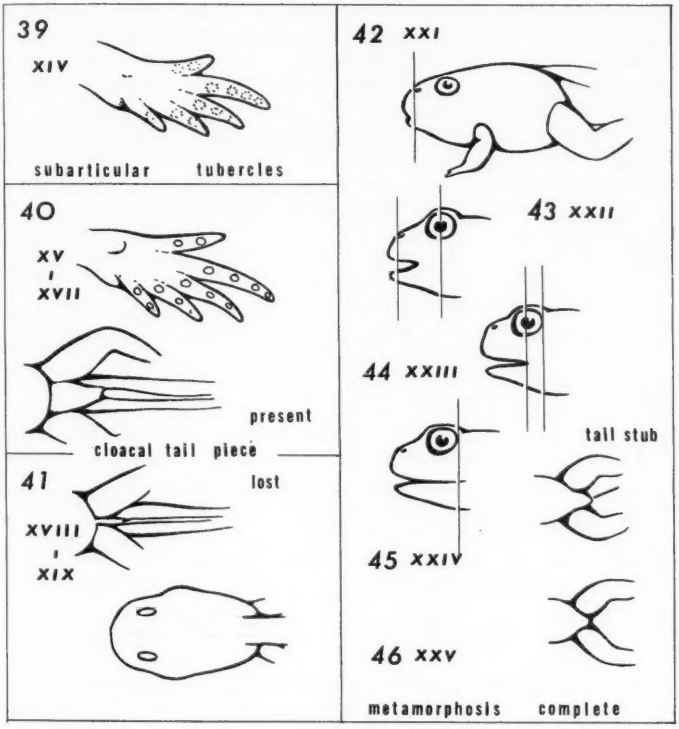
The oral disc and labial tooth rows begin to differentiate at about stage 23. The form of the oral disc is diagnostic for family identification, and its essential pecularities are present by about stage 26, although changes occur subsequently in the number and form of the oral papillae. The tooth rows develop gradually. While the "mature" tooth row formula of a species is usually established in the early larval stages, the relative proportions of the rows change during ontogeny. Allometric change is, perhaps, more pronounced here than in body proportions. The author has followed the custom of examining oral proportions as ratios using the length of the first upper labial tooth row as divisor. In *Scaphiopus* and certain ranids, at least, the number of tooth rows increases during the larval period. There is considerable variation in these traits, and aberrant mouth parts are common in some samples.

Larval Stages—The growth increment between stages 25 and 26 apparently is small in tadpoles of most North American pelobatids, bufonids, and hylids, but amounts to a considerable interval in some of the larger ranids. For this reason the designation of stage 26 as the first larval stage is somewhat arbitrary. It should also be noted that independent feeding actually starts in stage 25.

Identification of stages 26-40 is made by examination of the hind limbs. Stages 26-30 are easily determined by the length/diameter relationship of the developing limb bud. At stage 31 the "foot" is paddle-shaped, and subsequent stages through stage 37 witness the appearance of individual toes. Stages 38-40 are differentiated by proportional changes in the length of individual toes and in the appearance of metatarsal and subarticular tubercles. The latter appear as light patches in stage 39 and as actual tubercles in stage 40.

Limbaugh and Volpe (*op. cit.*) found that ratios of several body proportions in *Bufo valliceps* are relatively constant during this period, i.e. stages 26-40; mouth parts were unchanged between stages 29-40 and pigmentary patterns become stabilized at about stage 32. A comparable study of several species of New Jersey hylid larvae (unpublished data) indicates some allometric change in body part ratios and more extensive changes in labial tooth row proportions (see also Gosner and Black, *op. cit.*). While these changes are relatively slight during a considerable part of the

TABLE 3




larval period, they do complicate the use of such ratios for identification. The extent of change in pigmentation varies in different species. With these reservations in mind we may regard the period between stages 30 and 40, approximately, as one of relative stability in "key" traits.

Following stage 40 the more drastic changes of metamorphosis begin. Total length begins to diminish at this point through resorption of the tail; the larval mouth parts begin to break down. At stage 41 the skin over the forelimbs becomes transparent; the "cloacal tail piece" may disappear at this stage or shortly thereafter.

Stages 42-46 are identified by metamorphosis of the head indicated by changes in the mouth, particularly. Forelimbs appear in stage 42. At stage 46 metamorphosis is essentially complete. Newly

transformed young may or may not resemble the adults sufficiently to permit positive identification.

The chief value of staging tables lies in their use as a shorthand annotation in describing ontogenetic changes and comparing such data for different species. By plotting total length against developmental stages, size-staging graphs are obtained that permit the use of absolute size as a key trait. Without this correlation size data in keys are frequently of little value. In other studies the indication of staging data may enhance the usefulness of published material.

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COUNTING SCALES OF WORM SNAKES.—Counting scales of *Typhlops* and *Leptotyphlops* has always been a chore until I struck upon a method of stitching the specimens on light cardboard. Cut a small hole through which the snake's head may be thrust for determining head scales. Pass a threaded needle about an inch below the hole, upwards, over the snake and down through the cardboard. Continue similarly to about midbody where another hole has been cut for counting scales around midbody. Snake should lie across hole. Continue stitching to near vent where another hole may be cut to facilitate tail counting. Start counting from head, writing with pencil the number of scales at each cross stitch. Make a pencil mark at vent to facilitate counting to end of body and from vent to end of tail.—*Chapman Grant, Rt. 1, Box 80, Escondido, Calif.*

# Synonymy, Variation, and Distribution of *Ptychohyla leonhard-schultzei* Ahl. Studies of American Hylid Frogs. IV

*By* William E. Duellman

Since the description of *Hyla leonhard-schultzei* from Guerrero, México by Ahl (1934: 185-6), the only reference to the species in the literature has been the inclusion of the name in a checklist of the amphibians of México by Smith and Taylor (1948: 87). Through the courtesy of Dr. Heinz Wermuth I have been able to examine the holotype of *Hyla leonhard-schultzei* and to compare it with specimens in collections in the United States, including the holotypes of the species discussed below. That comparison reveals that *Hyla leonhard-schultzei* belongs to the genus *Ptychohyla* Taylor 1944) and that several other names, as shown in the snyonymy below, have been proposed for the frog that properly is to be known as:

*Ptychohyla leonhard-schultzei* Ahl

*Hyla leonhard-schultzei* Ahl, Zool. Anz., 106: 185-186, fig. 1, April 15, 1934 – *Holotype*: Zoologisches Museum Berlin No. 34353 from Malinaltepec, Guerrero, México; Leonhard Schultze collector. Smith and Taylor, Bull. U. S. Natl. Mus., 194: 87, 1948.

*Hyla godmani*, Ahl, Zool. Anz., 106: 186, April 15, 1934.

*Hyla pinorum* Taylor, Proc. Biol. Soc. Washington, 50: 46-48, pl. 2, fig. 2, April 21, 1937 – *Holotype*: University of Illinois Museum of Natural History No. 25049 from Agua del Obispo, Guerrero, México; Edward H. Taylor collector. Smith and Taylor, Bull. U. S. Natl. Mus., 194: 87, 1948.

*Ptychohyla adipoventris* Taylor, Univ. Kansas Sci. Bull., 30 (3): 41-45, May 15, 1944 – *Holotype*: University of Illinois Museum of Natural History No. 25047 from Agua del Obispo, Guerrero, México; Edward H. Taylor collector. Smith and Taylor, Bull. U. S. Natl. Mus., 194: 91, 1948. Stuart, Proc. Biol. Soc. Washington, 67: 169, August 5, 1954.

*Hyla milleri* Shannon, Proc. U. S. Natl. Mus., 101: 473-477, figs. 92b, 93a-c, 1951 – *Holotype*: United States National Museum No. 123700 from San Lucas Camotlán, Oaxaca, México; Walter S. Miller collector.

*Description of Holotype*: Female, having a snout-vent length of 23.5 mm.; tibia length, 14.0 mm. (59.5 per cent of snout-vent length); foot length (measured from proximal edge of inner metatarsal tubercle to tip of longest toe), 10.3 mm.; head length, 8.9 mm.; head width, 8.8 mm.; inter-orbital distance, 3.0 mm.; width of eyelid, 2.3 mm.; diameter of eye, 3.2 mm. Outer fingers one-third webbed; fourth toe one-half webbed; dermal fold along forearm and outer finger; tarsal fold well-developed; anal opening posterior. Dorsum grayish tan with dark brownish black blotch from occiput

to sacrum. Five dark transverse bands on thigh, six on shank, and four on tarsus. Venter cream-colored; edge of chin speckled with dark brown; white line over anus and white tubercles lateral to anus.

Since the holotype is a female the diagnostic generic characters —ventrolateral glands and horny nuptial spines—are not present.

Fig. 1. Adult male of *Ptycholyla leonhard-schultzei* (UMMZ 115514) from 9 km. S of Valle Nacional, Oaxaca. x 3.

Nevertheless, the broad flat head, blunt snout, long hind legs, and extension of the ventral color into the inguinal region are sufficient characters to show that this specimen is an example of the same species described by Taylor as *Ptychohyla adipoventris*.

The holotype of *Hyla pinorum* (UIMNH 25049) is an immature male of *Ptychohyla leonhard-schultzei*, having a snout-vent length of 26.7 mm. and a tibia length of 15.0 mm. (56.2 per cent of the snout-vent length). The dorsum is brown with scattered large dark brown spots; there are narrow transverse dark brown bands on the limbs. A white line is present above the anus; the tubercles lateral to the anus are white. The edge of the chin is flecked with black.

The holotype of *Ptychohyla adipoventris* (UIMNH 25047) is an adult male of *Ptychohyla leonhard-schultzei*, having a snout-vent length of 30.6 mm. and a tibia length of 15.8 mm. (51.6 per cent of the snout-vent length). The ventrolateral glands are thick and extensive; there are 56 horny nuptial spines on the right thumb.

Shannon (1951: 473) in his diagnosis of *Hyla milleri* did not mention the presence of horny nuptial spines on the pollex and the presence of ventrolateral glands. Instead, he characterized the species as having two vocal sacs. This is an error, for, like other members of the genus, the specimens comprising the type series of *milleri* have a single subgular vocal sac. The holotype of *Hyla milleri* (USNM 123700) is a male of *Ptychohyla leonhard-schultzei*, having a snout-vent length of 30.5 mm. and a tibia length of 15.0 mm. (49.2 per cent of the snout-vent length). There are no horny nuptial spines on the thumb; the ventrolateral glands are extensive.

*Variation*: Eight adult males have snout-vent lengths of 30.0-34.9 (av. 31.0) mm., tibia lengths of 14.7-17.5 (av. 15.7) mm., tibia/snout-vent length ratios of 49.0-51.7 (av. 50.3) per cent, and tympanum/eye diameter ratios of 45.7-51.5 (av. 49.4) per cent. Three females have snout-vent lengths of 29.6-30.5 (av. 30.2) mm., tibia lengths of 14.9-15.5 (av. 15.2) mm., tibia/snout-vent length ratios of 49.0-52.4 (av. 50.2) per cent, and tympanum/eye diameter ratios of 47.0-51.5 (av. 49.0) per cent. Smaller individuals (23.5 and 26.7 mm. in snout-vent length) have relatively longer hind limbs; in these two specimens the tibia/snout-vent length ratios are, respectively, 59.5 and 56.2 per cent. The number of horny nuptial spines on the pollex of six males varies from 24 to 79 (av. 52). In some individuals the spines are relatively large; in others they are smaller. In some specimens not all of the spines are covered with a horny excrescence.

The extent of the ventrolateral glands in the males is highly variable. In UIMNH 25047 the glands extend nearly from the axilla to the groin; they nearly meet on the midline of the chest. In USNM 123700-1 the glands extend well onto the ventral surfaces; in UMMZ 115514-5 the glands are somewhat less extensive, whereas in the other specimens they are poorly developed. Neverthless, in all males

the skin of the ventrolateral surfaces is noticeably thickened.

Apparently the development of the ventrolateral glands and horny tuberosities in the males is seasonal. Stuart (1954: 169) commented on this seasonal development in other members of the genus. In some specimens the glands are well-developed and the horny nuptial spines are absent, whereas in other specimens the reverse is true. For example, in UMMZ 115514-5 the horny nuptial spines number 57 and 79, but the glands are only moderately developed, whereas in USNM 123700-1 the glands are well-developed, but the horny nuptial spines are absent. The presence of these glands and horny spines in males only during the breeding season limits the usefulness of these characters, which have been used to diagnose the genus *Ptychohyla*. The application of these characters is further limited by the fact that they are absent in females.

*Coloration*: The color of the dorsum varies from dull olive green to grayish brown; usually a varying number of irregular darker brown blotches are present on the back. The limbs are colored like the body and are marked with dark brown transverse bands (Fig. 1). The ventral surfaces are creamy white; usually this light color extends onto the groin and sometimes onto the proximal part of the anterior surface of the thigh. Usually the border of the chin is speckled with black or dark brown. In life, each of two specimens from 9 kilometers south of Valle Nacional, Oaxaca (UMMZ 115514-5), had a dark brown dorsal ground-color with reddish tan blotches; the posterior surfaces of the thighs were orange-brown; the belly was white, and the iris was a rust-color. A specimen from Vista Hermosa, Oaxaca (UMMZ 119604), had a bronze-colored iris, black and white mottling on the flanks, yellow on the undersides of the hind limbs, and a pale blue axilla. Taylor (1944:43) stated that living specimens from Agua del Obispo, Guerrero, were dark green or greenish olive above and yellowish white below with flesh-colored ventral surfaces of the legs; the eye was a reddish color. Shannon (1951:474), quoting the collector's field notes, stated that specimens from San Lucas Camotlá, Oaxaca, were pale tan in life.

*Life History*: All specimens have been found in or near streams on mountain slopes. Calling males were found on August 31, 1939, at Agua del Obispo, Guerrero (Taylor, 1944: 44), February 23, 1956, at a stream 9 kilometers S of Valle Nacional, Oaxaca, and March 30, 1959, at Vista Hermosa, Oaxaca. The call is a series of two or three short, harsh notes, repeated at intervals of one and one-half to two minutes: "wrack-wrack-wrack"—"wrack-wrack."

Tadpoles of this species have been found in a rocky stream 9 kilometers S of Valle Nacional, Oaxaca; tadpoles possibly referable to this species are from San Lucas Camotlán, Oaxaca (Shannon, 1951: 476), and from 3 kilometers SW Huatusco, Veracruz. The following description is based on specimens from 9 kilometers S of Valle Nacional (UMMZ 118863).

An average-sized tadpole with small limb buds has a body length of 14 mm. and a total length of 43 mm. The body is moderately depressed; the greatest height of the body is equal to about three-fifths of its length. In lateral profile the head slopes gradually from the occiput to the snout. The spiracle is sinistral, lateral, and is situated about two-thirds the distance from the snout to the posterior edge of the body. The eyes are of moderate size and are located dorsolaterally. The nostrils are situated midway between the anterior edge of the eye and the tip of the snout. The tail is about twice as long as the body. The greatest depth of the tail fin is equal to about one-third the length of the tail. The tail musculature does not reach the end of the tail; the depth of the tail musculature is slightly more than five-eighths of the depth of the tail fin (Fig. 2).

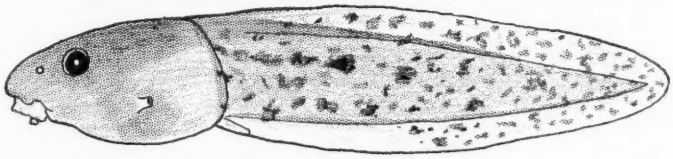

Fig. 2. Tadpole of *Ptychohyla leonhard-schultzei* (UMMZ 118863) from 9 km. S of Valle Nacional, Oaxaca. x 2½.

The mouth is ventral; its width is equal to about four-fifths of the greatest width of the body. Both lips are bordered by two rows of papillae; in the lateral corners of the mouth are five or six rows of papillae. The horny beaks are well-developed. The upper beak forms a broad, shallow arch, the ends of which point anteriorly; the lower beak is broadly V-shaped. The inner edges of both beaks are moderately serrated. There are four upper and six lower tooth rows. The upper rows are subequal in length; the fourth upper row is divided medially. The first and second lower tooth rows are about as long as the upper rows. Lower tooth rows three through six decrease in length; also, the teeth in these rows are smaller than in the others (Fig. 3).

The color in formalin is dull grayish brown with dark brown flecks; the ventral surfaces of the body are somewhat paler; the tail fin is transparent.

*Distribution*: *Ptychohyla leonhard-schultzei* is known from the foothills of Pacific slopes of the Sierra del Sur in Guerrero and from the lower Gulf slopes of the Sierra Madre Oriental in Oaxaca. On the basis of tadpoles questionably referred to this species the range may extend northward to central Veracruz. Probably the species ranges around the southern and eastern periphery of the Mexican Highlands. Specimens examined include the following:

*Guerrero*: Agua del Obispo, UIMNH 25047, 25049, 27305, USNM 114551; Malinaltepec, ZMB 34351, 34353. *Oaxaca*: San Lucas Ca-

motlán, UIMNH 3201, USNM 123700-1; 9 km. S of Valle Nacional, UMMZ 115514-5, 118863 (11 tadpoles); Vista Hermosa, UMMZ 119604. *Veracruz*: 3 km. SW of Huatusco UMMZ 119652 (15 tadpoles).

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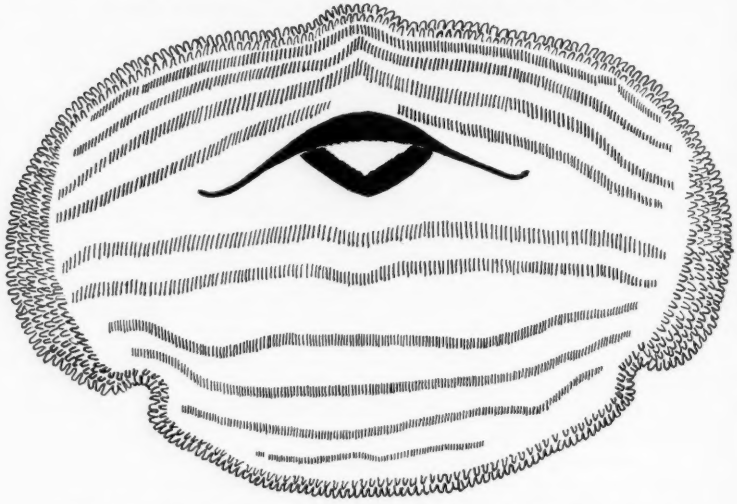

Fig. 3. Mouthparts of tadpole of *Ptychohyla leonhard-schultzei* (UMMZ 118863) from 9 km. S of Valle Nacional, Oaxaca. x 20.

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THE PRESENCE OF CERTAIN HERPTILES IN SOUTHWEST FLORIDA.—The following records were compiled to verify the presence of existing populations of certain reptiles and amphibians in southwest Florida, thought to be non-indigenous or in areas for which locality records were lacking. Included in the following account are three forms of amphibians and two of reptiles. At least one of these (*Ophisaurus*) can be regarded as a range extension, while the others may also be, or are merely local populations which needed to be substantiated.

I am indebted to Mr. George Weymouth of Bonita Springs Florida, as his willingness to assist me at often unruly hours or adverse collecting conditions was most helpful and appreciated. It is because of his enthusiasm that *Ophisaurus attenuatus longicaudus*, and *Scaphiopus h. holbrooki* appear here.

Specimens herein listed have been deposited in the following collections, whose abbreviations are: OSU - Mus. of Zool. of Okla. State Univ. CRI - Charles R. LeBuff, Jr. GW - George Weymouth.

According to Duellman and Schwartz (1958 Amphs., Repts., S. Fla., 226), *Pseudobranchus striatus belli* "is known only from a few localities in Dade County." Although this form has been thought to occur throughout South Florida's "Everglades" region, definite locality records have not been recorded. Locality records of three specimens are: 5 mi. SE Naples, Collier County, Florida (OSU A585 and A586). ½ mi. W Tamiami Trail (U. S. 41) on State Road 865, Bonita Springs, Lee County, Florida (CRL 205).

The two Naples specimens were taken in normal habitat, among hyacinth roots in the canal that borders the northern side of the highway. The individual from Lee County was found "free-swimming" in a cypress-willow pool at a depth of eight inches.

Records of the occurrence of *Notophthalmus viridescens piaropicola* in Southwest Florida are lacking. Locality records for five specimens are: 5 mi. SE Naples, Collier County, Florida (OSU A587 (3) and CRL 205). ½ mi. W Tamiami Trail on State Road 865, Bonita Springs, Lee County, Florida (CRL 204).

The four Collier County specimens were taken with the *Pseudobranchus* from the same locality at 3:30 p.m. on 17 October 1959,

also among the root systems of water hyacinths. The specimen from Lee County was collected from the same locality, at 11:20 p.m. on 22 August 1959. The Lee County *Notophthalmus* was slowly making its way through a maze of dead willow branches, and when an attempt was made to secure it, it would dart forward a few feet, conceal itself, eluding the collectors in this fashion several times. After an interval of a minute or so it would again appear among the branches, apparently feeding, where it was finally dipped into a collecting jar.

Supposedly, *Scaphiopus holbrooki* is distributed in or confined to the eastern portion of the Peninsula in South Florida. Locality data for ninety-seven Southwest Florida specimens are: 4 mi. W of Tamiami Trail, 200 yds. S State Road 865, Collier County, Florida (95). Bonita Springs, Lee County, Florida (2).

The ninety-five collected at the above location were in an extremely heavy and deafening chorus. Rainfall was very heavy and easily reached torrential status. The *Scaphiopus* were so numerous that the ninety-five were collected in no more than five minutes.

The southernmost portion of the range of *Ophisaurus attenuatus longicaudus* has been thought to terminate on Florida's west coast at Charlotte County and on the east coast at Dade County. One fine example of this lizard is available from Southwest Florida. The individual complies with the descriptions as published by Carr and Goin (1955 Repts., Amphs., Fishes, Fla., 222, 260) and Conant (1958 Guide to Repts. Amphs., 107). Locality information is: Center of Bonita Springs, Lee County, Florida, approximately 100 yds. N Imperial River, 150 ft. W Tamiami Trail (1) GW 173.

The collection of the above specimen has extended the range of *O. a longicaudus* between fifty and seventy-five miles further southward on the Gulf coast.

Another form until recently found only in southern Frorida on the east coast is *Eumeces egregius onocrepis*. Duellman and Schwartz state, "It is likely that *onocrepis* will be found in the vicinity of Naples. . ." Such has been the case, for the locality data on one adult is: 2 mi. N Naples, Collier County, Florida (OSU R1984).

This individual was collected at 4:00 p.m. on 21 August 1959 in optimum habitat for the form, beneath pine and rosemary humus on a relatively high, sandy ridge. Another was observed but not collected.

Until recently very little field work has been done on the herpetofauna of Southwest Florida. Perhaps the best explanation for this is the fact that identical situations occur to the north and east of the area. Thus the populations of the area under discussion have been overlooked. It is indeed surprising to learn that many University Museums lack specimens or series from this rich corner of Florida's fine assortment of herptiles.—*Charles R. LeBuff, Jr., U. S. Fish and Wildlife Service, Sanibel Island, Florida.*

## Mating Behavior and Eggs of the Plains Spadefoot

*By* DALE L. HOYT

Livezey and Wright (1947, Amer. Midland Nat., 37(1): 179-222) in their key to the eggs of the frogs and toads of the United States stated that measurements of the vitellus and envelopes of *Scaphiopus bombifrons* are needed. As recently as 1956, Smith (1956, Univ. Kansas Mus. Nat. Hist. Misc. Publ. no. 9, 2nd ed.: 1-356), in a key to the eggs of the frogs and toads of Kansas, did not include this species, although it is commonly found in the state. It therefore seems appropriate to present a description and measurements of the eggs of the Plains Spadefoot.

On the night of July 2, 1958, a series of forty adults was collected as they called from a temporary pool ¼ mile north of the Kansas State University Campus, Manhatten, Riley Co., Kansas. About 5:00 p.m. on this day a heavy rain began; by 7:00 p.m. 2.01 inches had fallen. By 12:30 a.m., July 3, another 1.32 inches had been recorded, and by 7:00 a.m. an additional 1.16 inches were reported. During this 24 hour period 4.49 inches of rain were recorded. Water temperature at 1:00 a.m. was 22.4° C.; air temperature, 22.2° C. The pool had a maximum depth of about one foot.

At about 9:00 p.m. three pairs in amplexus were collected, one pair from the bank of the pool, the other two from where they were floating in the water with only their heads visible. One clasping pair was placed in a gallon jar, half full of tap water. At 1:45 a.m., eight eggs were protruding from the cloaca of the female.

The pair dived to the bottom of the jar and were still for a moment; then the female contracted her sides, extruding a small number of eggs. At the same time the male arched his back, bringing his cloaca over the eggs, and contracting his sides. I was unable to see the seminal fluid ejaculated. The eyes of both the male and female were partially closed during this process and the male was observed to periodically bob his head up and down a short distance. The pair then rose to the surface and swam about vigorously, making it impossible to determine how many small egg masses were present or how many eggs were in each cluster. At 9:40 a.m. I caught the pair to determine whether the female was spent. She emitted several groaning "yelps" and the male released her. Both frogs were returned to the jar, but the male made no attempt to clasp. The male was then placed on the female and amplexus was resumed. At 10:15 p.m. on July 3, 1958, the eggs were preserved in a 12:1 solution of formalin. A total of 1909 eggs had been laid.

On February 20, 1960, 35 eggs, most of which were in the early gastrula and yolk plug stages, were studied. The color of the vitellus at the time of deposition had been dark brown at the animal pole and pale yellow at the vegetal pole. The vitelline membrane was

closely applied to the egg and visible only in eggs that had shrunk or pulled away from the membrane. Three envelopes were present, of which the two inner were much smaller than the outer one (Fig. 1). Of the two smaller envelopes, the inner was more distinct and was always easily seen. The second envelope was distinct but faint. Foreign material adhered to the third envelope, which was firm but easily torn.

Livezey and Wright (*op. cit.*) characterized the eggs of *S. bombifrons* as being black above and white below, each with two envelopes. Trowbridge and Trowbridge (1937, Amer. Nat., 71: 460-480) studied the cleavage rate of the eggs but made no mention of the number of envelopes or size of the vitellus. They described the egg as having a light brown animal pole and a creamy white vegetal pole. These descriptions are in contrast with my data.

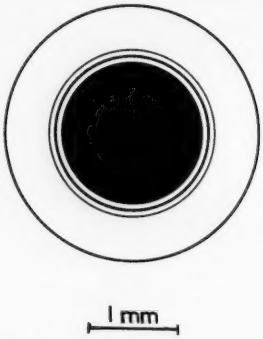


Fig. 1. Diagram of the egg of *Scaphiopus bombifrons*. X 14.

The eggs were measured with an ocular micrometer to the nearest 0.05 millimeter. The ranges in size (average measurements in parentheses) of the vitellus and encasing envelopes are: vitellus, 1.40 to 1.70 (1.57); first envelope, 1.55 to 2.00 (1.71); second envelope, 1.65 to 2.30 (1.83); third envelope, 2.25 to 3.50 (2.85).

Bragg mentioned measurements of the egg only in his key to the eggs of the frogs and toads of Oklahoma (1950, Univ. of Oklahoma Press). He characterized both *S. hammondi* and *S. bombifrons* as having a vitellus of from 1.0 mm. to 1.61 mm. in diameter. In my data the average diameter of the vitellus falls within this range.

The genus *Scaphiopus* has been divided into two subgenera, *Spea* and *Scaphiopus*, by various authors (Tanner, 1939, Great Basin Nat., 1: 3-25; Bragg, 1944, Amer. Nat., 78: 517-533; Blair, 1955,

Texas Jour. Sci., 7: 183-188). The eggs of the members of the subgenus *Scaphiopus* (*hurteri, holbrooki,* and *couchi*) all have a single, indistinct envelope, wheras *S. hammondi* has two well defined envelopes (Livezey and Wright, *op. cit.*), and *S. bombifrons* has three. Both *hammondi* and *bombifrons* are members of the subgenus *Spea;* the eggs of the third member of this subgenus, *S. intermontanus,* are as yet unknown (see Zweifel, 1956, Amer. Mus. Novitates, no. 1762: 1-45, for a discussion of the specific status). The information available concerning the condition of the egg envelopes supports the division of the genus into the subgenera *Scaphiopus* and *Spea.*

*Acknowledgments*: I thank Henry S. Fitch and William E. Duellman for their suggestions and comments on the manuscript. I am indebted to Barbara Berg, who was of great assistance in clarifying the manuscript.

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A RANGE EXTENSION OF THE SWAMP SNAKE, *SEMINATRIX PYGAEA PALUDIS* DOWLING.—Through the Spring and Summer of 1959, the authors were engaged in gathering material for a forthcoming paper based upon collections of herpetozoa from Hyde and Tyrrell Counties, N. C.

During the afternoon and early evening of July 31, heavy precipitation occurred throughout the area. Immediately following the storm the junior author collected a specimen of *Seminatrix p. paludis,* AOR, 15 mi. S Columbia, Tyrrell Co., through an area of extensive swamp.

The previous northernmost record for *paludis* is represented by two specimens taken at Beaufort, Carteret Co., N. C., and examined by Dowling in his description of the subspecies. ("Studies of the Black Swamp Snake, *Seminatrix pygaea* (Cope), With Descriptions of two New Subspecies," Misc. Pub., Mus. Zoology, Univ. Mich., No. 76, 1950). The present example, (WMP-DEW 331), extends the range of the form above the Pamlico Sound and about 70 mi. NE of the Beaufort locality.

The specimen, an adult male, measuring 356 mm. t.l., is typical of the race and agrees with the scale characters outlined by Dowling (*op. cit.*): dorsal scale rows 17-15, ventrals 131, caudals 50.—*W. M. Palmer* and *David E. Whitehead, N. C. State Mus. Nat. Hist., Raleigh.*

# Variation with Age of the Electrophoretic Protein Pattern in Turtle Blood[1]

*By* HAROLD M. KAPLAN
*With the Technical Assistance of* LORETTA YOH

Animals appear to change their resistance and susceptibility to disease at different ages. Some of this defensive ability resides in the globulin fraction of the serum proteins.

The level of the proteins has already been investigated at different ages in the blood of various mammals (Halliday and Kekwick, 1957; Rutquist, 1958) and also in the blood of the frog (Frieden *et al*, 1957). Significant differences have been found. It is of interest to determine whether similar developmental changes occur in the turtle.

## MATERIAL AND METHODS

Baby turtles with an average shell length of 1.5 inches were compared with adult turtles with an average shell length of 7.5 inches. All animals were red-eared turtles, *Pseudemys scripta elegans*. The use of more than one species might in itself produce variations in the proteins (Zweig and Crenshaw, 1957). Also, since the protein pattern has been found to vary with sex (Dessauer and Fox, 1956), only females were used. All animals were fed and kept under similar conditions.

The blood was drawn in adults by running a syringe with a #20 hypodermic needle down the side of the neck in the intact animal, and aspirating the heart. The blood was drawn in nembutalized baby turtles by removing the plastron and inserting a #27 hypodermic needle into the ventricle of the exposed heart. In all cases the blood was allowed to clot in a refrigerated centrifuge at 5,000 r.p.m. for 5 minutes. The serum was then analyzed in a Spinco electrophoresis apparatus having a Duostat power supply.

About 24 lambda (microliters) of the serum were applied with a striper, filled with a micropipette, to Whatman #3 MM filter paper strips in the electrophoresis chamber. The strips were previously saturated in the chamber for one-half hour in the vapors of a buffer solution, Spinco Buffer B-2 (2.76 gm. diethyl barbituric acid and 15.40 gm. sodium diethyl barbiturate per liter of distilled water; pH 8.6 and ionic strength 0.075).

The proteins of the serum were allowed to separate on the strips at 6 ma. (at 110 volts) for 23 hours, at approximately 25° C. The strips were denatured in an oven at 115-130° C. for 30 minutes. The dried strips were stained for 16 hours in Spinco Dye B-1 (0.1 gm. bromphenol blue, 50 gm. zinc sulfate, and 60 ml. of 80 per cent acetic acid, diluted to one liter with distilled water).

1. Supported in part by the NSF Undergraduate Research Participation Program.

The strips were rinsed twice, for 5 minutes each, in 2 per cent acetic acid, and finally for 10 minutes, without agitation. They were fixed for 2 minutes in a solution containing 20 gm. sodium acetate per liter of 10 per cent acetic acid. The strips were blotted with filter paper and dried for 10 minutes in an oven preheated to 115-130° C.

All strips were analyzed by scanning in an Analytrol densitometer. The curves illustrated in Fig. 1 were thus obtained. The area under each curve was estimated from saw-teeth marks traced by the Analytrol pen; this is not shown in Fig. 1.

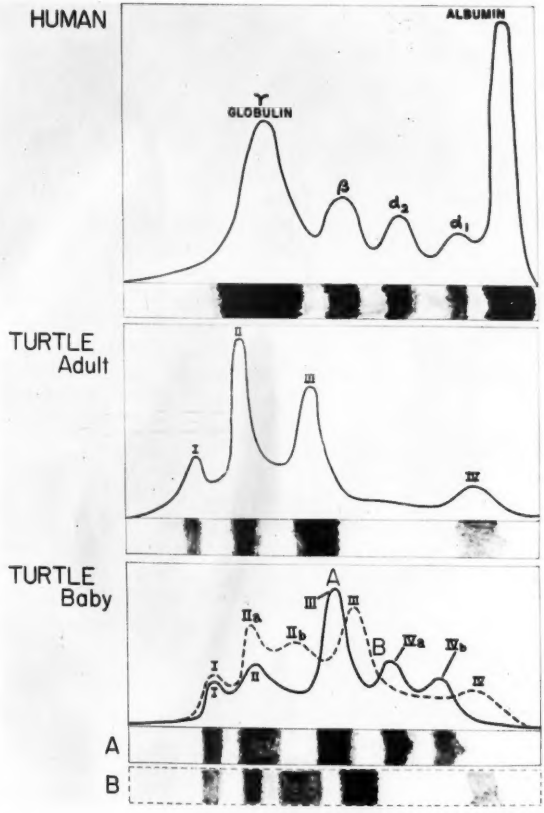


Fig. 1. Electrophoretic patterns in the serum of adult and baby turtles, *Pseudemys scripta elegans*. A human record is included for comparison.

Total proteins were determined chemically on duplicate samples of several runs by a Microkjeldahl method (Hawk *et al*, 1954). The amount of each electrophoretic protein fraction, in gm./100 ml. of blood, was then computed from the estimated areas under the individual curves.

## EXPERIMENTAL DATA

By Kjeldahl analysis, the average total serum protein of 21 adult turtles, of average shell length 7.5 inches, was 6.03 ± 0.77 gm./100 ml. of serum. That of 21 baby turtles, of average shell length 1.5 inches, was 1.57 ± 0.39 gm./100 ml. of serum.

The total protein in 55 other adult turtles separated typically to four electrophoretic fractions. These fractions are listed only in Roman numerals since there is no assurance without adjunctive chemical analysis that they correspond with the albumin and the several globulins of human serum. Fraction IV had the greatest electrophoretic mobility and Fraction I the least.

The average amount of each fraction, in gm./100 ml., and the percentage of each in the total protein, are listed in Table 1.

The total protein of baby turtles showed essentially the same major electrophoretic fractions as that of adults. There were additional peaks, however, and these were of two kinds.

In one kind (Group A), a component corresponding most closely to Fraction IV of the adults was subdivided to two subfractions,

Table 1. Variation of serum proteins between baby and adult female turtles, *Pseudemys scripta elegans*.

| | Adult turtles | | Baby turtles | |
|---|---|---|---|---|
| Average shell length in inches 21 turtles | 7.5 | | 1.5 | |
| Average total protein in gm./100 ml. of serum 21 turtles | 6.03 ± 0.77 | | 1.57 ± 0.39 | |
| Protein fractions in gm./100 ml. of serum | (55 animals) | | Group A (13 turtles) | Group B (32 turtles) |
| | I. 1.37 ± 0.57 | | I. 0.19 ± 0.06 | I. 0.09 ± 0.03 |
| | II. 2.24 | 0.65 | II. 0.37 0.08 | IIa. 0.19 0.02 |
| | III. 1.50 | 0.46 | III. 0.60 0.10 | IIb. 0.29 0.05 |
| | IV. 0.91 | 0.37 | IVa. 0.27 0.05 | III. 0.52 0.07 |
| | | | IVb. 0.15 0.04 | IV. 0.48 0.08 |
| Percentage of each fraction in the total protein | I. 22.7 | | I. 11.8 | I. 5.9 |
| | II. 37.1 | | II. 23.5 | IIa. 11.9 |
| | III. 24.9 | | III. 37.8 | IIb. 18.5 |
| | IV. 15.1 | | IVa. 17.2 | III. 33.2 |
| | | | IVb. 9.7 | IV. 30.5 |

termed IVa and IVb. In the second variety (Group B), a component apparently corresponding to Fraction II was subdivided to two subfractions, termed IIa and IIb.

All data for the turtles are listed in Table 1. Representative curves for baby and adult turtles are illustrated in Fig. 1. A sample record of human blood is drawn for purposes of comparison.

Neither the adult nor the young turtles revealed any peak having the mobility of serum albumin. This is in agreement with known facts about the absence or paucity of albumin in adult turtles (Cohen and Stickler, 1958). There has been no previous account, so far as the author is aware, of the blood chemistry of young turtles.

## DISCUSSION

A female turtle with a carapace length between 7-8 inches belonging to *Pseudemys scripta elegans*, is assumed herein to be an adult. This conforms with known measurements (Carr, 1952).

Baby turtles appear to possess protein fractions that are not present electrophoretically in adults. The reasons are unknown. These fractions are apparently globulins, since there is no electrophoretic evidence of any albumin in the blood of the babies. This protein is simply not characteristic of *Pseudemys* and apparently of any other genus of turtles at any age.

Baby turtles possess low total protein concentrations. This is a reflection of a lower globulin fraction. These globulins, however, are distributed differently from the adult, not only in kind but in quantity. The turtle is able to form significant quantities of globulins at a very early age.

Since globulins are associated with resistance to infections, these findings may be of interest in terms of variations in the immunity of turtles with age. Some inferences concerning immunity and biochemical evolution among the poikilotherms may possibly be derived eventually from such studies.

It might have been advisable to extend this study to turtles of other sizes and ages, to try to analyze in more detail the developmental changes in the proteins.

## SUMMARY

The total serum protein of turtles belonging to *Pseudemys scripta elegans* rises from 1.57 gm./100 ml. in animals of 1.5 inch shell length to 6.03 gm./100 ml. in animals of 7.5 inch shell length.

The total proteins of the adults separate to four electrophoretic fractions, all of which are probably globulins. There is no evidence for albumin.

The total proteins of the young turtles separate electrophoretically in a basically similar manner to that of the adults. There are,

however, two sub fractions of Fraction II in one group of babies and two subfractions of Fraction IV in another group. Also, the percentage of each fraction varies between the young and the adult turtles.

The young turtles show no electrophoretic evidence of serum albumin.

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DEPARTMENT OF PHYSIOLOGY, SOUTHERN ILLINOIS UNIVERSITY, CARBONDALE, ILLINOIS

A PINK BELLIED *TANTILLA*.—A *Tantilla* taken at Hebbronville, Jim Hogg Co., Texas, April 13, 1960, appears to be *gracilis* B. & G., having six upper labials; one postocular; ventrals 130; 135 mm. total length. The head is gray, the color extending three scales behind head. It differs from F. M. Blanchard, (Zool. Ser. Field Mus. Nat. Hist., 20, Apr. 20, 1938: 369-376) in that it is decidedly red underneath from 30th ventral to tip of tail; reddest near vent, instead of "The coloration of all our species is uniform except for a black cap, . . ." This seems to be a range extension from Duval Co., next north of Jim Hogg Co.—*Chapman Grant, Rt. 1, Box 80, Escondido, Calif.*

# *Plethodon erythronotus* (Raf.), the Red-backed Salamander

*By* Clyde F. Reed

There has been uncertainty about the nomenclature of *Plethodon erythronotus* (*cinereus*) since Green (1818, Sept.) stated that he was using Rafinesque's name, *Salamandra erythronota*, for the red-backed salamander. In 1953 while I was studying the scarlet phase of the red-backed salamander in Connecticut (Reed, 1955), it became apparent that Rafinesque had described the red-backed salamander in March, 1818. That Rafinesque had so described this salamander prior to Green's use of the name (Green, 1818, Sept.) had been alluded to by several herpetologists, but none had been able to locate his original description. Therefore, I wish to show by citation of the leading herpetological treatments of *erythronotus* and *cinereus* that the proper name for the red-backed salamander is *Plethodon erythronotus* (Raf.).

Because of the rarity of the journal in which Rafinesque's name, *Salamandra erythronota*, (for the red-backed salamander) appeared, his entire article is repeated here. 1818 (March). Rafinesque, C. S., Description of a new American Salamander—The Red-backed Salamander from the Highlands. The Scientific Journal of New York, 1(2): 25-26. Ed. W. Marrat. (Library of Congress Microfilm — 01104. No. 239 AP).

"P. 25. I am acquainted already with about 10 species of North American salamanders, most of which have not yet been described by naturalists. I have described several in my memoirs, presented to the Literary and Philosophical Society of New York and the Lyceum of Natural History of New York; they generally belong to the water salamanders with compressed tails, which form the genus *triturus* (sic) of Duméril and myself; but I now mean to describe a real land salamander, with cylindrical tail, which has been presented to the Lyceum, having been found by Mr. Vesplanck on the Highlands: Dr. Samuel Mott had also seen it formerly. Salamanders differ from lizards by having a naked skin without scales, toes without nails, and being tadpoles, like frogs, in the first stages of their existence.

"*Salamandra erythronota*. Red Back Salamander.—Definition. Back red, with a black line on each side, and a crenulated reel in the middle; belly grey, spotted brown; tail rather longer than the body, and blackish. Description.—Total length about four inches, head very obtuse, flattened, brown above, yellowish underneath, mouth large, eyes nearly round and brown; back of a fine red margined with two narrow black lines, beginning behind the eyes and ending on the tail; the middle of the back has a crenualted reel, which does not protrude on the tail, which is slender, brown or blackish, a little obtuse at the tip, and longer than the body. The feet are small, the anterior have four toes, the posterior five, whereof the lateral ones are very short; they are entirely cleft. Observations: It is found on hills and rocky situations of the state of New York, on the Highlands, etc. It moves slowly and takes shelter under stones. It lives on insects."

Rafinesque's description quite clearly refers to the Red-backed salamander; his type locality is clearly stated as New York. In a paper originally read at the Philadelphia Academy on May 12,

1818, Green (1818, Sept., p. 356) stated in a note that "I have given Mr. Rafinesque's name of a species found in rocky situations in Newyork (sic) to this, believing them to be only varieties. This animal is not very rare in Newjersey (sic). It is found under stones, in high places." However, Green did not cite Rafinesque's reference, and this fact in itself leads to misunderstanding in the nomenclature of the Red-backed salamander.

Green's descriptions for *S. erythronota* and *S. cinerea* follow for purposes of comparison with Rafinesque's original description:

"*Salamandra erythronota*, Cauda brevi, corpore supra fusco rubroque variato, subtus cinereo. Red-back Salamander. Length between 3 and 4 inches; tail rather shorter than the body, tapering, cylindrical and pointed; snout obtuse; eyes prominent black; back red, mixed with brown, the colours form a stripe from the snout to the end of the tail; beneath cinereous; throat whitish, with a few dots of crimson near the neck; anterior feet four-toed, posterior five-toed.

"*Salamandra cinerea*. Cauda longiuscula, corpore supra fusco, albo maculato, subtus nigro albo distincto. Dapple Salamander. Length about 4 inches; tail longer than body, tapering cylindrical and pointed; head long; upper parts bluish; snout obtuse; back dark brown, sprinkled with small white dots; beneath black and white mixed; throat whitish; eyes large and prominent, pupil round and black, iris yellowish brown; anterior feet three-toes, with a small thumb, posterior four-toes with a small thumb."

Green's main distinguishing characteristic, other than the color of the back, is whether the tail is shorter or longer than the body. This character is not reliable, since the ratio of length of tail to body is variable. Rafinesque had stated "tail longer than the body" for *S. erythronota*, referring to the form with "back red." Green stated "tail longer than the body" for *S. cinerea*, but "tail rather shorter than the body" for *S. erythronota*, thus altering Rafinesque's description. Harlan (1827) repeated Green's description, including the differences in the length of the tail. Although Green made other minor variations in the descriptions of the number of fingers and toes and in the color of the belly, it is quite clear that he and Rafinesque were talking about the same salamander.

Green described *Salamandra erythronota* before he described *S. cinerea;* he referred, even though indirectly, to Rafinesque's earlier description, as we now can see, citing the locality in the original description. Therefore, at this point it is clear that *erythronota* has priority over *cinerea*. However, it is from Green's descriptions and subsequently from Harlan's descriptions that confusion has arisen.

Harlan (1827, p. 329) was confused as to whether Rafinesque or Green had described *S. erythronota*, and therefore cited the species as – "S. *erythronota* Raf. Green, Jour. Acad. Nat. Sci. Phila. 1: 356." Harlan's descriptions are repeated here for both species, since it is from his use of the names that Tschudi (1838) made his transfer of *cinerea* to *Plethodon*.

"P. 329. *Salamandra erythronota*. *S. erythronota* Raf. Green, Jour. Acad. Nat. Sci. 1: 356. Characters: Tail rather shorter than the body, cylindrical, tapering, and pointed; above red, mixed with brown; the colours forming a

stripe from the snout to the end of the tail; beneath cinereous; throat whitish. The young have no brown mixed with the red. Length 4 inches. (P. 330) Inhabits New Jersey, under stones, etc., in high places.

'*Salamandra cinerea*. S. *cinerea* Green, Jour. Acad. Nat. Sci. 1: 356. Characters: Tail longer than the body, cylindrical, tapering and pointed; back dark brown, sprinkled with white dote; beneath black and white, mixed; throat whitish. Toes very minute; four before; five behind. Length 4 inches. Inhabits New Jersey. Specimens in the cabinet of the Academy from South Carolina." (Note: The specimens from South Carolina do not belong here, according to Richard Highton.)

First of all, Harlan described *S. erythronota* before *S. cinerea;* thus *erythronota* should have priority. But what is confusing is the fact that Harlan described each species as though he were describing new species, since he cited *S. crythronota* Raf. Green and *S. cinerea* Green as synonyms, even though his descriptions for either species did not deviate perceptively from that of Green. Second, while Green's and Harlan's descriptions of *S. erythronota* are quite similar, slight discrepancies in their descriptions of *S. cinerea* are: Green gives "upper parts bluish" to what appears to be in reference to the head; Harlan says nothing about this item, but does cite the South Carolina specimen which does not belong here. It is surprising that Tschudi (1838) should choose Harlan's descriptions of *S. erythronota* and *S. cinerea* upon which to base his *Plethodon cinereus*, instead of either Rafinesque's or Green's of 1818.

Tschudi (1838, p. 28) described the genus *Plethodon*, basing it mainly upon *Salan andra glutinosa* var., Green (1827, Jan.). Actually, Creen had des ribed *S. glutinosa* in 1818, just following his descriptions of *S. erythronota* and *S. cinerea*. When describing the genus *Plethodon*, Tschudi used little more than the following 'notes.'

"*Salamandra glutinosa* var. Green in Contrib. of the Maclurian Lyceum to the Arts, etc., 1: 6, t. 2. Jan. 1827, gehort, hieher; er sagt in der Diagnosis: (58) Cauda mediocri – corpore supra fusco maculis albidis – subtus albidus. Tail the length of the body, tapering, much compressed and slightly carinated on the lower half of its upper and under edges; teeth minute. – *Salamandra cinerea*, kleiner als *glutinosa*, grau, mit seiner rötlichen und weisslichen Punkten übersäet."

Tschudi identified *Plethodon cinereus* as having grey with reddish and whitish dots on the upper side. Until this note, *cinereus* had not been identified as having any red on its body. Tschudi indicated that he based his species *Plethodon cinereus* upon Harlan's descriptions of *S. cinerea* and *S. erythronota*. It is unfortunate that Tschudi selected *cinereus* for the specific epithet, since up to this time *erythronota* had had priority.

The reference to Tschudi (1838) for *Plethodon* should not be pp. 59-92, as cited by Cope (1869, p. 100). The description for the genus *Plethodon* is on page 58; the species are listed on page 92. Hence:

"*Plethodon* Tschudi. Class. d. Batr., Mem. Soc. Sci. Nat. Neuchatel 2:

58, 1838. Based on *Salamandra glutinosa* var. Green, Contrib. Maclurian Lyceum to the Arts, 1: 6, t. 2. 1827 (Jan.) and *S. cinerea* Harl.

"*P. glutinosus* (Green) Tschudi, Class. d. Batr., Mem. Soc. Sci. Nat. Neuchatel 2: 92, t. 2, f. 4. 1838. Based on *Salamandra glutinosa*, above, and Jour. Acad. Nat. Sci. Phila.

"*P. cinereus* (Green) Tschudi, Class. d. Batr., Mem. Soc. Sci. Nat. Neuchatel 2: 92. 1838. Based on *Salamandra cinerea* Harl.—*Salamandra erythronota* Harl."

Note: Tschudi used Syst. d. Batr., Trans. Neuchatel 1838: 58 and 92, for this reference, even though these titles do not appear on the article or publication.

Fitzinger (1843, p. 33) established his genus *Sauropsis* on *Salamandra erythronotus* Raf., thus making the transfer *Sauropsis erythronotus* (Raf.) Fitzinger. It is obvious that Fitzinger knew about Rafinesque's name, since he made his transfer from Rafinesque's name, rather than from Green's or Harlan's. He completely excluded *S. cinerea* from his list, as though it had no status. Under *Plethodon* Tschudi, Fitzinger included *Plethodon glutinosus* Tschudi (l.c., p. 34). Also included in Fitzinger's *Plethodon* is a new genus *Saurocercus*, based on *Cylindrosoma longicauda* Tschudi (America). Under the genus *Sauropsis* Fitzinger, he included: 1. *Batrachoseps* Bonap. (*B. attenuatus* Bonap.); 2. *Sauropsis* Fitz. (*Salamandra erythronota* Raf.); 3. *Hemidactylium* Tschudi (*H. scutatum* Tschudi).

Gray (1850, 37-38) misquoted Fitzinger's generic name as *Saurophis*, hence the names *Saurophis* Fitz. and *Saurophis erythronota* Fitz. appear. Also Duméril & Bibron (1854, p. 86) misquoted the genus as *Saurophis* Fitz., in synonymy.

Although Tschudi had transferred *cinereus* to *Plethodon*, he had not transferred *erythronotus*, primarily because he included *S. erythronota* Harlan in the synonymy of *Plethodon cinereus*, and included the outstanding character of *S. erythronota*, namely the red back, in his description of *Plethodon cinereus*. Baird (1850), believing *erythronota* to be distinct from *cinereus*, made the transfer *Plethodon erythronota* (sic) (Green) Baird, based upon *S. erythronota* Green 1818, Sept., with a note, "Green quotes this species from Rafinesque whose description I cannot find." Baird also gave *Plethodon cinereus* (Green) Tschudi, based on *S. cinerea* Green, 1818, Sept. The gender of *Plethodon* as established by Tschudi is masculine, so *erythronota* is orthographically incorrect.

Gray (1850, pp. 37-38) transferred *erythronota* to *Ambystoma*, as *A. erythronotum* (Green) Gray, based on *S. erythronota* Green. He cited as synonyms: *S. cinerea* Green, 1818; *Plethodon cinereus* Tschudi; *Plethodon erythronota* Baird, 1849 (1850); and *Saurophis* (in error) *erythronota* Fitz., 1843. From this synonymy it is clear that Gray only considered *erythronota* as representing the Red-backed salamander.

Duméril and Bibron (1854, pp. 86-87) totally confused the issue

by citing *Plethodon erythronotum* Tschudi, based on *Salamandra erythronota* and *cinerea* Green (1818, Sept.). Although Tschudi had not made this combination, even though he had based his *P. cinereus* upon Harlan's descriptions of *S. erythonota* and *S. cinerea*, it is interesting to note that Duméril and Bibron recognized that *erythronota* was the more proper name to accept. In the synonymy cited by Duméril and Bibron appeared *Plethodon cinereum* (sic) Tschudi, Class. Batr., p. 92. 1838. Again, *erythonotum* and *cinereum* are orthographically incorrect in *Plethodon*.

Cope (1869, pp. 99-100, combinations on page 100) gave the following grouping of the varieties for *Plethodon erythronotus*:

"*Plethodon erythronotus* Green.

1. var. a. *cinereus*. Based on *Salamandra cinerea* Green (1818, Sept.); *Plethodon cinereus* Tschudi (1838).
2. var. b. *erythronotus*. Based on *Salamandra erythronota* Green (1818, Sept.); *Plethodon erythronotus* Baird (1850). (N. B. Green quotes this species from Rafinesque, whose description I cannot find.)
3. var. c. *dorsalis* Baird, M.S. 3776. Louisville, Kentucky; Salem, Mass."

Here again, Cope, like Fitzinger, Baird and Gray, chose to use *erythronotus* as the specific epithet for the Red-backed salamander, thus submerging *cinereus* to a variety or subspecies.

Davis and Rice (1883, pp. 26-27) made the following new combinations for subspecies of *Plethodon cinereus*, along with a note that both subspecies are found in all parts of the state of Illinois.

"*Plethodon cinereus* Green, subsp. *cinereus* Green; Davis & Green, Bull. Chicago Acad. Sci. 1(3): 26. 1883.

"*Plethodon cinereus* Green subsp. *erythronotus* Green; Davis & Rice, Bull. Chicago Acad. Sci. 1(3): 27. 1883."

Dunn (1926, p. 163) attributed *Plethodon cinereus cinereus* to Davis and Rice, but overlooked the fact that they had also made the combination *Plethodon cinereus erythronotus*, since he attributed this combination to Cope (1889, Bull. U. S. Nat. Mus., 34: 135). Cope merely gave the original authority, Green, without specifying who made the combinations. *Plethodon cinereus erythronota* Britcher (1903, p. 120) is superfluous and orthographically incorrect (*erythronota* should be *erythonotus* under *Plethodon*).

Dunn (1926, pp. 163-180) chose to use *Plethodon cinereus* (Green) for the Red-backed salamander, giving no reasons for submersing *Plethodon erythonotus* in the synonymy of *P. cinereus*. For by this time everybody was using it. It seems that up to the early 1920's *P. erythronotus* had been in use; but after that time most herpetologists have used *P. cinereus* to represent the red-backed salamander. This decision may have been prompted by the inability of herpetologists to find a definitely published account of *Salamandra erythronota* by Rafinesque, coupled with a definite ani-

mosity toward anything Rafinesquian by most naturalists for a long time; and by the use of *Plethodon cinereus* by Tschudi, which should prove something as to the status of the two names, even though Tschudi had cited both names.

It is unfortunate that at this late date we should find Rafinesque's original clear description of a salamander which had been given such a well selected descriptive name, *erythronota*, meaning red marked, because there are those herpetologists who would rather conserve the name *Plethodon cinereus*, regardless of how improper its selection had been in the past, if for no reason other than that they have used this name for the past thirty or forty years. I am not one for changing names, but in all fairness to Rafinesque, the name *erythronota* should be retained for the Red-backed salamander and the combination *Plethodon erythronotus* (Raf.) should stand to represent this salamander. Since Tschudi had incorporated the concept of *erythronotus* in his *P. cinereus* and although he had unfortunately selected *cinereus* as the specific epithet, it would not be incongruous to establish *Plethodon erythronotus* (Raf.). Duméril and Bibron (1854) had even gone so far as to call the species *Plethodon erythronotum* Tschudi, based on *Salamandra erythronata* and *cinerea* Green.

I wish to thank Dr. Doris M. Cochran, Division of Reptiles, United States National Museum, for her assistance in locating literature and in making it available for my study.

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REED HERPETORIUM, 10105 HARFORD ROAD,
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MELANISM IN *STORERIA DEKAYI*.—In the spring of 1956, two melanistic *Storeria d. dekayi* of moderate size were found under debris in a large field in Bellerose, Nassau County, N. Y. Several of normal coloration and a few *Thamnophis s. sirtalis* were also taken in the same area. Both melanistic snakes were lost, and that same year a factory was built on the site, destroying the habitat.

On May 8, 1958, a small melanistic *Storeria* was found under a large rock in a vacant lot on Hempstead Ave. in Queens Village, Queens County, N. Y. *Storeria* of normal coloration were also found; however a large population was never present. The melanistic specimen is a male with scutellation typical of *Storeria d. dekayi*. The dorsum, eyes and tongue are black, with the head shields a shiny metallic; the venter is a light bluish-gray. In bright light a faint pattern is visible. It grew considerably until its death on March 27, 1960, when it was approximately 298 mm. in total length. It is now No. 84194 in the collection of the American Museum of Natural History.

The individual at the second locality may be the offspring of a snake brought from the first locality, as some were released in this lot.—*Charles W. Heckman, 100-50 223 St., Queens Village 29, N. Y.*

# Treetoad Studies, 1. *Hyla californiae*, New Species

*By* Joe Gorman

H. W. Henshaw's 1875 collection of two treetoads from "Southern California" is accessioned in the Smithsonian Institution (USNM) collections (No. 8694) as *Hyla arenicolor* Cope 1866 (neé *Hyla affinis* Baird 1854).[1] They were so named in a discussion of the species distribution. habits, and variation by Richardson (1912), who, however, noted differences in wartiness of the skin, in blotching and especially in the relative smallness of the eye and eardrum diameters in the California forms, as compared with specimens from Arizona.

Contemporary herpetologists, Wright and Wright (1949:290), Stebbins (1951:322), and Bogert (1957, 1958/a), have noted these and other noteworthy differences between populations of Canyon Treetoads on opposite sides of the Mojave-Sonora Deserts of North America. Figure 1 shows some of the typical differences characteristic of these populations. Those west of the deserts should be considered as:

*Hyla californiae*[2], new species
(California Canyon Treetoad)

*Type specimen*: Museum of Vertebrate Zoology (University of California, Berkeley) 31773, adult female from Canyon de Llanos, 9 mi. (14.5 km.) SSW of "Alaska" [La Rumorosa], Partido del Norte, Baja California, Mexico, obtained 10 June 1939 by R. R. Miller and J. Davis (Fig. 2).

*Diagnosis*: California populations of Canyon Treetoads differ among western North American Hylidae in many ways. Adpressed ankle reaching front of eye; eye small; eardrum small and obscure, greatest diameter less than one-half of horizontal diameter of eye. Premaxillary ridges ("canthus rostralis" of authors) distinct; nares subterminal below premaxillary ridge; irregular spots and blotches of melanin on back; peritoneum covering testes (of mature males) blackish. The voice is a soft monotone of medium pitch, with a medium-wide pitch range with two higher dominants, of

1. Published in June 1855. I cannot ascertain that J. H. Clark, the collector, who was in Emory's United States and Mexican Boundary Survey Commission as principal assistant astronomer, was in Los Nogales before June 21, 1855.

2. I first used that name in the title of a paper presented at the 1957 meetings of the American Society of Ichthyologists and Herpetologists at Stanford University (with the American Institute of Biological Scientists in the Bulletin of which the title appeared). C. M. Bogert used this name in his notes accompanying his fine recordings of anuran calls released in 1958 by Folkways Records and Service Corporation of New York City, a use predicated on my publishing before the record (and its accompanying leaflet) was released. So fit is this name, I prefer to risk a *nomen nudum*, and, if necessary, to appeal for its legalization to the International Commission on Zoological Nomenclature.

Fig. 1. Variation among North American Canyon Treetoads; left, Millard Canyon, Los Angeles Co., California; center, Nevada de Coliam, Jalisco, Mexico; right, Zion Nat. Park, Washington Co., Utah. (from a color photograph by Robert Stebbins.)

medium slow (among anurans) vibrations (sometimes called "notes;" see description of voice below).

The only other treetoad known to occur in the range of *californiae* is *Hyla regilla*. *H. californiae* differs from *regilla* as follows: no black-brown stripe from jaw through eye to shoulder; skin rougher with melanin distributed irregularly rather than in triseriate lines; webbing on toe reduced; voice soft and monotonous rather than sharp and two-noted.

*Description of type*: An adult female, squat, unevenly and sparsely warty on the back, and much marked with melanin blotches; nostrils raised, originating just below distinct premaxillary ridges, and subterminal. Backs of thighs irregularly blotched; specimen with a white spot obliquely under eye, and an obscure eardrum, snout rounded in both dorsal and side view, and markedly protuberant (i.e. chin receding). Belly unevenly warty, from fine grain on thighs forward to medium granular at the breast fold, thence more finely to chin; thigh or groin markings absent. Finger webs much reduced (practically absent) and toe webs reduced. My measurements in millimeters of the type specimen follow: snout-vent 44.3, head 11.9, arm 28.1, leg 63.6, snout-width 4.3, head width at eye 14.7, at ear 17.0, snout through ear (on side) 13.8, eyeball (in orbit, horizontal length) 5.3, ear (tympanum, longest diameter) 2.8, upper arm 6.4, lower arm 8.1, wrist+hand 4.1, longest finger (3rd) 7.5, thigh 15.7, lower leg 19.5, ankle 10.8, foot 7.9, longest toe (4th) 10.1.

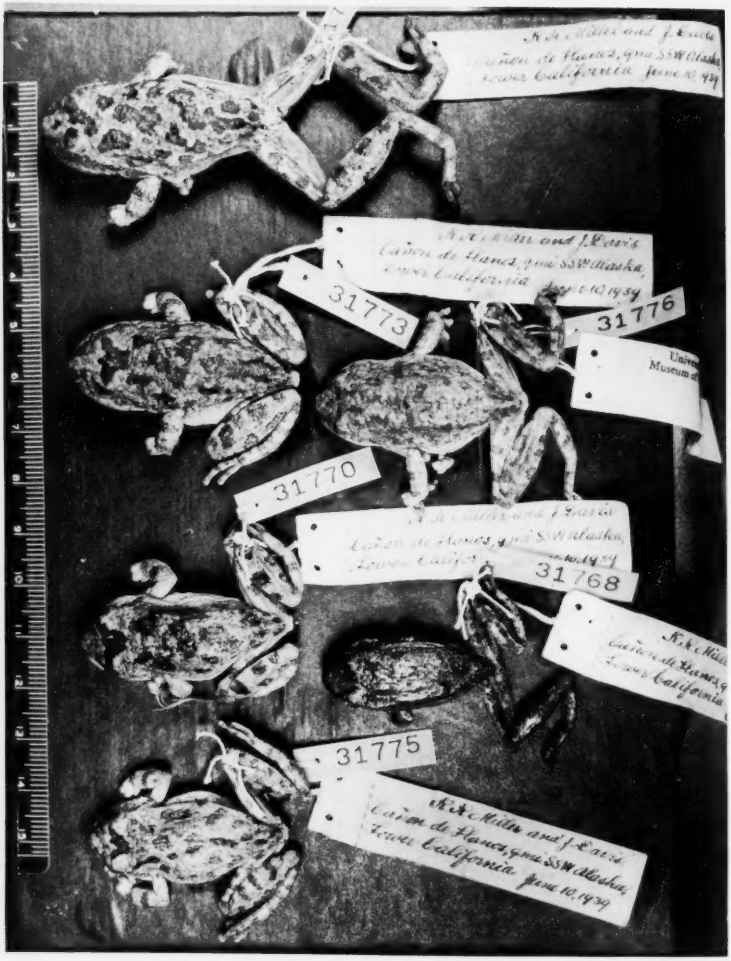


Fig. 2. The type specimen of *Hyla californiae* and a part of the type collection of *Hyla californiae*. (Photo by Martin Schweig).

*Summary of type series*: The type specimen is typical of the 13 adults of the type series MVZ 31766-72, 31774-9 (Fig. 2). The range of variation within this paratype series shows the typical variations commonly found in *Hyla californiae* populations. The only male shown is MVZ 31768; the others are smaller, darker

brown with more spotted melanin, and with the warts more evenly spaced on the backs than in the females. Means with standard deviations of the measurements of the adults of the paratypic collection follow (in the same order as for the type specimen above): 39.37±.4, 11.7±.6, 24.1±1.1, 58.6±2.1, 3.9±.2, 13.1±.6, 14.6±.6, 12.3±.6, 4.9±.3, 2.3±.1, 6.2±.6, 7.2±.4, 4.1±.5, 6.6±.3, 15.6±1.1, 18.4±.7, 8.9±.6, 6.8±.4, 9.3±.4.

The collection is an adequate sample from near the middle of the present distribution of this species. I do not know where Henshaw's two specimens from "Southern California" (one immature and a newly metamorphosed one) were collected, although I judge they came from within the central area, which extends from the Mexico-California border northward to central Los Angeles County, California.

The type of paratypes of *H. californiae* vary at most subspecifically from other California Canyon Treetoad populations. These variations will be noted in a subsequent paper.

*Hyla regilla* and *H. californiae* are ecologically separated; *californiae* is usually found near pools of fast streams with steep banks, and *regilla* is usually found in shallow, slow streams flowing through grassy (swampy) fields and in ponds. *Hyla regilla* is common in its niche; *H. californiae* is relatively uncommon. Occasionally they are found together. Brattstrom and Warren report *californiae* (their "*arenicolor*") - *regilla* hybrids, and I concur. These seem prevalent in the region of central Los Angeles County. The marks of these hybrids seem to be the combination of the preocular line with the subocular white spot, usually with a smoother skin and reduced digital pads with increased webbing.

The closest species to *H. californiae* morphologically is *Hyla arenicolor*, the probable sibling or parent species occurring east of the Mojave-Sonora Deserts. The range of *H. arenicolor* extends in the foothill canyons of the Sierra Madre Occidental-Rocky Mountain range from Guerrero, Mexico, north-northwest to southern Utah, east to south-east Colorado and south to extreme west Texas. The type series of *Hyla arenicolor* Cope 1866 [neé *Hyla affinis* Baird 1854] (USNM 11410) consists of 4 adult and 1 young specimens.* I independently selected as the lectotype specimen the one seemingly measured by Cope (1889:370). Moreover, Cope (1889:369) refers to this specimen as not lacking the white spot below the eye, as do the paratypes; the spot can be seen in the specimen second from the right in Figure 3, although the photograph fails to show its lack among the others. I recommend restriction as the type speci-

*This collection is misnumbered in both Yarrow, (1882:175) and Cope, (1889:369) as 11411, which is a *Lampropeltis g. getulus* "hatched in museum case"; moreover, Yarrow lists 1 specimen, "type," but Cope writes of 11410 as "one of the types from Sonora."

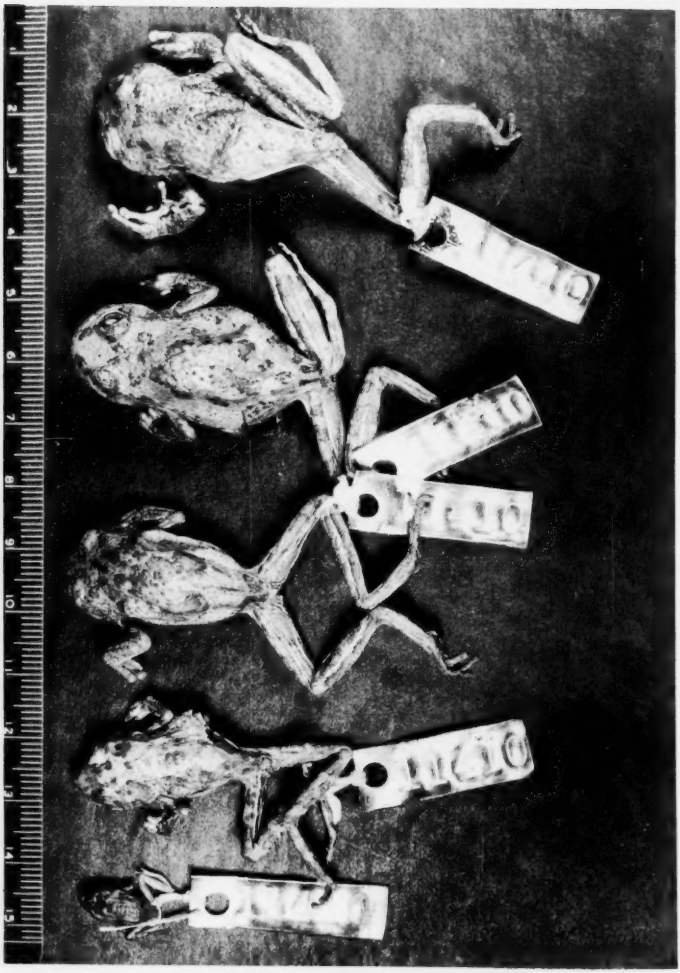

Fig. 3. The type series of *Hyla arenicolor*. Holotype (see text) is second from the right (Photograph by Martin Schweig).

men of the species *Hyla arenicolor* Cope 1866 to this specimen of the USNM collection 11410. I further recommend the restriction of the type locality to Peña Blanca Springs, 10 mi. (16 km.) NW Nogales, Santa Cruz County, Arizona.[3] Means and standard deviation of measurements of the 4 adults including 3 paratypes of

USNM 11410 are (in mm. and in the order used previously above): 38.9±4.3, 11.5±.4, 24.3±.8, 56.0±1.1, 4.4±.4, 12.3±.2, 14.8±.8, 9.4±.2, 4.9±.4, 2.9±.3, 5.6±.6, 6.5±1.0, 3.6±1.0, 6.9±.9, 16.1±1.1, 16.6±.8, 9.0±.5, 6.1±.5, and 8.1±.9.

*Hyla californiae* appears most closely related to *H. arenicolor* but has the following additional distinguishing marks: larger melanic markings on the back, as blots or blotches, rarely only spots, and a limited chromophoric color range, from whitish (ash) gray to cream (light-medium brown in southern poplations). *H. arenicolor* rarely, if ever, lacks some cream-dark brown color, but I know of no study on either species of color variations among and of individuals. In *californiae* toe webs are larger than in *arenicolor*, the palmar tubercles smaller, the second finger longer, the belly warts finer and more evenly grainy, somewhat tuberculate in *arenicolor*. If present, the yellow color is reduced in *californiae*, and the backs of its thigh have irregular melanin blotches rather than more even banding.

A most important diagnostic difference is the voice, which I find hard to describe. Readers are referred to the fine recordings by Bogert (1958 (a): bands 33, 37), and Miller. Despite Bogert's audial data and suggestion, I hesitated to call these western *arenicolor* a new species because the variations of form did not quite convince me that there were differences of species magnitude, especially in the southwest populations.

The voice of *californiae* is higher in pitch, wider in pitch range with two major dominant frequencies, at 1200 and 3600 cycles per second (hereinafter cps). The dominants are less distinct in the full range of about 800-1000 to about 4000 cps than are the different dominant frequencies of *arenicolor*. In *californiae* each vocalization is about 1.5 - 2 seconds, each note (really a chord) about 120 milliseconds with a distinct interval of about 50 milliseconds. In contrast, the voice of *arenicolor* is a chordal monotone more restricted in range, about 500-2200 cps, dominantly around a guttural of about 600 cps, with accompanying notes of about 1500, 1800, and 2100 cps (but in my recorded calls of two specimens from Texas, only the 600 cps dominant appears). The total phrase is about 1-1.5 sec., each note about 40 milliseconds with an interval of about one half to twice the duration of the note. These characteristics summate nicely into distinctly specific impressions as reported by Bogert (1958 (a) ), and found by me in Baja, California. It must be noted, however, that much variation between individuals occurs, probably in

3. Yarrow (1875:587): "It will be remembered that the present Territory [Arizona] includes the western half of what was formerly New Mexico, together with a considerable part of Sonora, obtained by what is known as the 'Gadsden purchase'; consequently, many species described from 'New Mexico' and 'Sonora' are really Arizonan."

relation to age, temperature, etc., and this voice discussion is based on very few specimens of either species.

*Ecology and Natural History*: *Hyla californiae* is separated on the east by the Mojave and Sonora Deserts from the nearest *arenicolor* populations by a distance of nearly 250 miles (392 km.) northeast, and about 220 miles (357 km.) east. A legend persists of a treetoad population in Yuma County, Arizona (Palm Canyon, Kofa Mountains), which I twice visited in dry weather without finding specimens of *Hyla*.

Collections of *californiae* and *arenicolor* are small, rarely more than twelve to a series. They are rarely found in trees, usually occurring on rocks, often in bright hot sunlight, but within a jump of a deep pool. *H. californiae* differs from *arenicolor*, especially the northern *arenicolor*, in sitting with the body more lifted from the rock (cf. Wright and Wright, 1949:290), and in jumping more quickly into the pool. *H. arenicolor* squats flat on the rock, rarely moving when closely approached or touched, especially during the bright day hours.

Both breed following rainstorms, appearing some days after the storms, after the first turbulent wash of water down canyons slows, allowing sedimentation and quiet deep pools to form. They often call in dry weather at the approach of storms. In the Californias, with a Mediterranean climate (Köppens), the rains come from November to May. Thus *californiae* appears after *regilla* and breeds from mid-March to mid-June, in temperatures much cooler than for *arenicolor*. Ecologically the California Canyon Treetoad is to be expected northward in the canyons of the tributaries of the Salinas River, some of which I searched in vain.

On the east side of the Mojave-Sonora Deserts, most of the rains come in the hot summer often lasting for only an hour or two. Two dangers to survival are: heating and subsequent desiccation of eggs in rapidly drying pools, and the concentration of predators around the breeding pools. Deserts occur between the eastern edge of the range of *californiae* and the western edge of *arenicolor*. A comparable gap occurs in the Sierra Madre Occidental-Rocky Mountains and populations west-of-the-Pecos in Presidio, Brewster, and Jeff Davis Counties, Texas. An interesting ecological outpost also occurs in Joshua Tree National Monument, San Bernardino County, California.

I am most grateful to Dr. Robert C. Stebbins for his continued encouragement and help. An American Philosophical Society (Philadelphia) grant of $337.00 was crucial in allowing me to collect and restudy *californiae* in the field, particularly in Baja, California. The Museum of Vertebrate Zoology, University of California, Berkeley, the American Museum of Natural History, especially Charles M. Bogert, Dr. Sidney Lanyon in the use of the Sonograph analyser, and Miss Theresa Curtin, the Museum of Natural History, University of

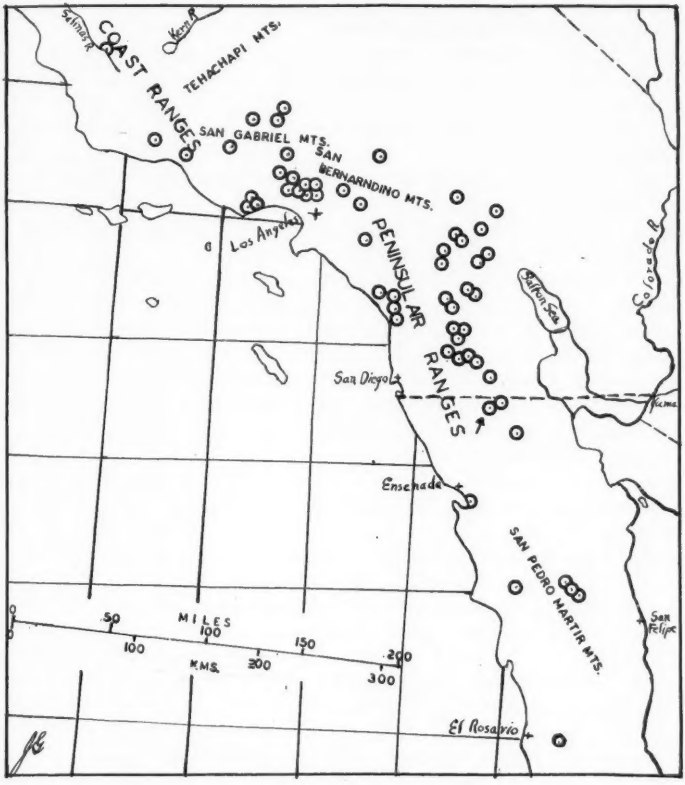


Fig. 4. The distribution of *Hyla californiae*. The type locality is shown by an arrow.

Kansas, Professor Edward H. Taylor, and the Smithsonian Institute which lent freely of their collections and gave other help. Mr. Pete Algra of Bakersfield made several important *californiae* collections.

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HERPETOZOA FROM TABASCO.—Mr. Vernon E. Thatcher of Louisiana State University collected 122 amphibians and reptiles of 49 species near Teapa, Tabasco, June 19-August 29, 1958, and February 23-July 18, 1959. Forty-seven specimens of the 1958 collection were identified by E. H. Taylor and have not been re-examined by me; they represent 34 species of which 20 were not duplicated in the 1959 collections. Taylor retained five duplicates for his personal collection. All of the 1959 collection and one specimen of the 1958 collection were identified by me; of these, 26 were retained for the Museum of Natural History, University of Illinois. All other specimens are in the Louisiana State Museum of Zoology, to whose curator, Dr. George H. Lowery, I am indebted for the privilege of examining this collection.

Five species, not previously reported from Tabasco, are in the

two collections (*Phrynohyas modesta* (1), *Chelydra serpentina* (1), *Constrictor constrictor imeprator* (2), *Tretanorhinus nigroluteus lateralis* (3), and *Coniophanes quinquevittatus* (3), but these do not involve unexpected range extensions. The only species of rarity is *C. quinquevittatus*, concerning which certain comments follow. So few locality records are available for Tabasco, however, that a list of the other species obtained but previously recorded from the state is of value.

All specimens, with a few noted exceptions, were taken in an area 6 miles in diameter on the Teapa River centering near the headquarters of the Colorado ranch. This area is east of the highway between Villahermosa and Teapa, about 15 miles north of Teapa. The species previously recorded from the state are: *Dermophis m. mexicanus* (4), *Rhinophrynus dorsalis* (14), *Bufo horribilis* (2, Teapa), *B. valliceps* (1, 5 mi. N Teapa), *Leptodactylus melanonotus* (1, Teapa), *Hyla picta* (1), *Smilisca baudini* (1, Teapa), *Rana palmipes* (1, Teapa); *Dermatemys mawi* (1), *Kinosternon leucostomum* (1), *Claudius angustatus* (1), *Staurotypus triporcatus* (1), *Geomyda areolata* (1), *Pseudemys scripta ornata* (1); *Sphaerodactylus g. glaucus* (2), *Sceloporus teapensis* (1, 3 mi. E Teapa; 2, 15 mi. N Teapa), *Lepidophyma f. flavimaculatum* (1, Soledad; 3, Teapa), *Ameiva undulata amphigramma* (10), *Mabuya brachypoda* (4); *Bothrops atrox aspera* (3), *Clelia c. clelia* (1), *Coniophanes bipunctatus biseriatus* (8), *C. imperialis clavatus* (3), *Constrictor c. imperator* (2), *Dryadophis melanolomus veraecrucis* (1), *Drymarchon corais melanurus* (2), *Drymobius m. margaritiferus* (1), *Imantodes cenchoa leucomelas* (1), *Lampropeltis triangulum polyzona* (2), *Leptodeira septentrionalis polysticta* (4), *Leptophis m. mexicana* (1), *L. occidentalis praestans* (2), *Micrurus affinis alienus* (2), *Natrix rhombifera werleri* (3), *Ninia s. sebae* (9), *Oxybelis aeneus auratus* (1, Teapa; 1, 15 mi. N Teapa), *Pliocercus e. elapoides* (1), *Spilotes pullatus mexicanus* (1), *Thamnophis sauritus chalceus* (2), *Tropidodipsas s. sartori* (1, in cave, Teapa).

*Coniophanes quinquevittatus* (Duméril and Bibron). Three, with 152-153 (♂) and 157 (♀) ventrals, 65 (♀) and 70 (♂) caudals. The species is astonishingly similar to *bipunctatus*, but is readily separable in ventral and caudal counts, and also in pattern; in all *quinquevittatus* the dark dorsal ground color ends sharply along the 2nd scale row, whereas in *bipunctatus* it becomes lighter ventrally but clearly extends onto the ends of the ventrals. These specimens are the first from a definite locality in Mexico. Others have been recorded in Mexico only from the "Coatzacoalcos River, Veracruz," and although the type locality of a synonym, *Hydrops lubricus*, has been restricted to Puerto Mexico, Veracruz, this does not represent a known locality of capture.—*Hobart M. Smith, Department of Zoology and Museum of Natural History, University of Illinois, Urbana.*

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RANGE EXTENSIONS FOR TWO SOUTHEASTERN SKINKS. Specimens of two species of skinks contained in the herpetological collection of Auburn University come from localities which represent extensions of known ranges.

*Eumeces anthracinus pluvialis* Cope. A single subadult measuring 47.2 mm. s-v was taken by the writer approximately three miles south of Geneva, Georgia, on the Talbot-Marion County line, on April 7, 1959. It was found near the edge of a grassy seep on an open slope in an area of mixed pine and hardwoods. The example appears to fall definitely within this subspecies, exhibiting dark juvenile pigmentation, reddish snout and lips, 26 scale rows around the body, and supralabials 7-7. This record is a considerable extension of the known range, falling roughly 140 miles south of the known limits of distribution in northern Georgia, and an equal distance east of the nearest record in Alabama. It establishes the presence of the species in west-central Georgia, and indicates a wide distribution for the form in eastern Alabama.

*Eumeces egregius* Baird. One specimen was taken by Mr. William H. Adams, Jr. three miles northwest of Wadley, Randolph County, Alabama, on March 29, 1958. The animal was under a flat rock in a granitic outcropping of several acres extent. The species has long been known in Alabama only from the extreme south, although Conant (1958, Field Guide to Reptiles and Amphibians) has indicated an additional record from the vicinity of Tuscaloosa in the west-central portion of the state near the fall line. Hamilton and Pollack (1958, Herpetologica 14: 25-28) recently recorded the species as far north as Chattahoochee County in extreme western Georgia. The present record extends the range some 66 miles northwest of the Georgia locality. Although the Tuscaloosa record falls an equal distance to the north, the new record is a range extension for eastern Alabama, and more important, for the first time establishes the presence of the species well above the fall line. Most previous records of the species appear to be from areas of deep sandy soil, but the presence of the animal on the Piedmont would seem to indicate a wider ecological tolerance. The specimen has dorsolateral light stripes which fade out rapidly on the anterior part of the trunk, 22 scale rows around the body, and 63 ventral scales from snout to vent. These characters are not consistent with those of the race *Eumeces e. similis* as described by McConkey (1957, Bull. Fla. State Mus. 2:13-23) from Georgia and northern Florida, and suggest that specimens from more upland areas may represent a morphologically distinct population.—*John S. Mecham, Department of Zoology-Entomology, Auburn University, Auburn, Alabama.*